EXPLORING SCIENCE
Four

THURBER

CURRICULUM

Teachers' Edition

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Teachers' Manual for
EXPLORING SCIENCE
Four

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Introduction

PUTTING SCIENCE IN THE CURRICULUM

"Learn through doing!" "Study things—not ideas!" What excellent precepts for a science programme! For children love to "do" more than they care to sit passively. And they learn best when they are using their senses to study the world about them.

Imagine a cheerful classroom with children taking care of radish seedlings and goldfish; with children keeping records of tadpole growth and weather changes; with children making model boats and cricket cages; with children comparing what books say about robins with their own observations; with children experimenting, arguing about results, and suggesting new ways to prove that there is water in the air.

This is a picture of a science programme that is meant for children. These children are learning more than isolated facts; they are learning to work together, to solve problems, to handle tools, to use books. And they love every moment of it!

Teaching like this is fun. The outcomes are highly satisfying. Children need only the ideas for things to do, a little help in finding materials, and some encouragement. They supply the necessary enthusiasm and energy.

Some Reasons for Elementary Science

The elementary school is concerned with the growth of the child, —his intellectual, social, emotional, and physical growth. All subject-matter areas have the same general objectives, but they use different methods and content for attaining them. Science, because it deals so much with tangible things, makes several unique contributions.

Much of the programme of the Exploring Science Series involves manipulation, thus developing muscular co-ordination, skill with tools, and familiarity with materials. A number of otherwise outstanding pupils are seriously deficient in manipulative ability, this phase of their education having been neglected. They benefit greatly from opportunities to work with the "things" of the science programme. In contrast, there are a number of retarded readers who find in this phase of science their only opportunities to equal or excel their classmates.

A rich variety of science projects gives all children opportunities for self-expression. Some children best express themselves by making models; some through making friezes, charts, and posters; some by writing science stories, keeping notebooks, and producing science plays; some through collecting and exhibiting.

Science activities encourage pupils to plan, to use ingenuity, and to exercise initiative. When the activities are carried out by small groups, the pupils learn to plan and work together, to share responsibilities, and to assume leadership.

Experiments, field trips, projects, and similar activities stimulate pupils to turn to books for information. By comparing what authorities say with their own observations, the pupils tend to become more critical and they develop habits of open-mindedness and delayed judgment.

Certain phases of the subject matter of science have immediate and important values. Especially important are the learnings that contribute to establishing better health and safety practices. A large share of health and safety education is based upon scientific information. Another area that benefits from science subject matter is conservation education; so closely is conservation allied with science that the two are usually included in the same programme. (Pages 16–18 of this Teachers' Edition discuss the role of science in conservation and health and safety education.)

How Much Time for Science?

"Can you afford fifteen minutes three times a week for science?" This in answer to teachers who are concerned about the already crowded class curriculum. Successful science programmes have been carried out with as little time as this scheduled for science class work. More time is to be desired, but there need be no sacrifice of other important areas when science is added to the school programme.

An elementary science programme does not demand a great deal of formal class time to keep it progressing satisfactorily. Three or four short periods weekly, or the equivalent, are adequate for pupil motivation, with much of the actual science work being carried on outside class time. Most of the units in the Exploring Science Series require two or three weeks for satisfactory development—for planning, experimenting, and discussing.

Science does not require much class time because children make time for science. They find the work too exciting to be dropped between lessons. They rush to school in the morning to see how their plants and animals have fared through the night. They use much of their free time during the school day for science activities. If permitted they will stay after school to work with science materials. And it is not unusual for a majority of the pupils to repeat at home the experiments they have carried out during their science lessons.

It is possible to make science the core of the entire school programme; many children prefer to make science just that. Many children prefer to talk and write about science for their language work; many prefer to read about science during reading periods; some prefer to base their art work on science subjects. As one teacher put it, "I have learned how to start a science programme. Now show me how to stop it!"

Planned and Incidental Science

A planned programme ensures steady progress from grade to grade with a minimum of overlapping and repetition. A planned programme ensures breadth of content and a balance among the various subject-matter areas of science.

A planned programme gives point and direction to the work of the pupils and keeps their enthusiasm high. It opens up new avenues for exploration. Without planning, science programmes usually become haphazard and are sometimes neglected.

On the other hand, there should be time available for what is called "incidental" science. Pupils should have an opportunity to watch a butterfly that has just emerged or to study a rainbow that has just appeared in the sky. Incidental science deals with the unexpected; it is often responsible for some of the most worth-while outcomes of the science programme.

Equipment for the Science Programme

Mayonnaise jars, tin cans, paper clips, and soda straws—such are the materials needed for a science programme. There is nothing mysterious about these commonplace materials. When a child does an experiment with a mayonnaise jar he is working with something familiar to him. He can repeat the experiment at home if he wishes. To him, science is the study of famliar things.

A list of materials needed for each unit of the Exploring Science Series is included in the specific suggestions for teaching each unit. A list of all the science materials needed for the year's programme is included at the end of this Teachers' Edition. Children can supply most of the items, such as tin cans and glass jars. Some of these should be stocked in quantities so that there is always a supply on hand.

It is well to make a list of materials that children cannot bring in. This list may include such raw materials as soft pine lumber, wire, nails, and screws. The list should then be discussed with the principal or the supervisor for items that can be supplied by special departments of the school system. Usually only a few items need be purchased separately.

Ideally, materials for an activity programme should be provided in quantity. Instead of a single hand lens, a class of thirty children should have at least fifteen hand lenses. Although this may seem prohibitively expensive it need not be so. Other teachers in the school will probably be able to use the same materials. By providing a central storage space, and by working out a schedule for the use of the materials, the per-pupil cost becomes insignificant.

HOW TO USE THE BOOKS

Each pair of facing pages in the books of the Exploring Science Series sets the stage for an exciting adventure in science—an experiment, a demonstration, a field trip, a class project. The books are study guides rather than science readers. They present a programme to the pupils and show them how to carry it out.

Some teachers may choose to follow the books page by page, deviating little from the programme as it is presented. Their classes will be meaningful and fun for the pupils.

Other teachers will prefer to modify the programme to fit their special needs. Each book has been planned to permit a high degree of flexibility. How to take advantage of this flexibility and other features are discussed below.

How the Books Are Organized

Science experiences form the basis for the Exploring Science Series. Emphasis is upon first-hand experience activities supplemented by information given through pictures and reading.

The activities have been selected to provide experiences in all the common areas of science, both physical and biological. This presents a well-rounded programme that appeals to different interests and gives a broad background in science.

The activities are grouped in units centred about such familiar subjects as "Mirrors" and "Sunshine" rather than in units of formalized science. A single unit can, and often does, cut across several conventional subject-matter areas.

The material of a unit is developed in two-page blocks, each of which usually takes up a separate topic. This is a successful pattern often found in how-to-do-it books. It is useful in these science books because pupils can carry out an activity without turning pages.

The Teachers' Editions

The special Teachers' Editions for the Exploring Science Series contain the material given in the pupils' editions together with detailed suggestions for using this material.

Each unit is introduced with a discussion of the possible outcomes of the unit and a description of the part the unit plays in the entire science programme. Necessary materials are listed. Different methods of developing and enriching the unit are suggested, and valuable background information is provided.

Following these general helps, the material in the unit is considered page by page. Different methods of developing lessons are suggested. There is advice about the use of tools and materials. Possible difficulties are anticipated, and suggested things for the teacher to say in the classroom are in bold-face type. Answers to questions pupils might ask, follow-up activities, and references are listed. See PREPARING FOR THE UNIT for the best time to begin a unit.

The Teachers' Editions give teachers confidence in their ability to teach science. The Teachers' Editions help teachers take full advantage of the special features of the book, thus providing a rich and challenging programme.

Scheduling Science

Most of the units in the Exploring Science Series require two or three weeks for satisfactory development. Children should not be hurried through a science programme. They need time to experiment, to discuss results, to try experiments again. They need time between lessons, too. A pupil who has connected a dry cell to an electric lamp during a science lesson will want to repeat the experience during his free time. He may also wish to repeat the experience at home.

Most of the two-page blocks of a unit serve as the subject for one or more lessons each. One of these blocks may describe an activity that requires a full lesson for completion. Some of the activities may be started in one lesson, as with many experiments with plants, and then finished during a lesson at a later time. Field trips require additional lessons for preparation and for follow-up. Projects usually require several lesson periods.

It is recommended that the minimum time allotment for science be scheduled as lesson periods. Additional time can be used for incidental science or for extending scheduled lesson periods as needed.

There are several ways to provide additional science time without scheduling it at the expense of other subjects. If there is a "science table" at the side of the room, materials may be placed on it for pupils to use in their free time, both in and out of school hours. Individual projects can be started in school and completed at home. There can be correlation with reading, language, art, and social studies. As long as the science programme is interesting, the pupils will find time for it.

Modifying the Basic Programme

Perhaps spring comes early to your section of the country. Perhaps your community makes much of Fire Prevention Week. The teaching calendar should recognize these and other important events. The flexibility of the Exploring Science Series makes it possible to shift units as desired because the units within a book are independent of each other. A unit involving fire can be moved to early fall, and a unit involving spring can be scheduled for the time when daffodils burst from the ground.

Likewise the material within a unit may be re-organized to take advantage of special conditions. Re-arrangement of the two-page blocks may permit a more suitable activity to open a unit. Additional activities can be inserted as desired. One may also delete some of the activities that do not seem appropriate to the teaching situation.

The class may wish to take up science material that is not included in the programme of the books. This is admirable and the class should be given every encouragement. There are a few cautions that should be observed. The teacher should be sure that the subject is of interest to all pupils and not to just a few of the more aggressive individuals. She should be sure that there are suitable activities to be used in teaching the proposed subject. She should try not to take up material that will be taught by teachers in later grades. If pupils suggest a topic that does not seem suitable for the entire class, the topic may be assigned to certain interested pupils as optional work. Assigning a particular topic to a superior child will frequently re-awaken his interest by confronting him with a real challenge to his ability.

Beginning a Unit

To start children thinking about magnets put magnets in their hands. To start them thinking about frogs put a frog where they can watch it. That is all there is to starting a new unit.

New materials may be presented in several ways. Sometimes, as with magnets, the materials may be put in the hands of the pupils with little explanation. Sometimes an interesting demonstration can be used; for example, a "race" with burning candles under various-sized jars to see which candle goes out first. Living things, particularly things that move, need only be placed where pupils can watch them.

Special days and special events offer possibilities for introducing new topics. A St. Patrick's Day carnation raises questions that lead to experiments with water movement in plants. Coloured Easter eggs raise questions about dyes that lead to experiments with dyeing cloth.

First-hand experiences make the most interesting and the most challenging approaches to new units. There can be no one best approach to a unit because conditions vary so much, but a little imagination adapts most activities to meet the situation.

Developing a Unit

The pattern in which the material is presented in the Exploring Science Series is one that has been used successfully, but it is not necessarily the most satisfactory for a particular situation. There can be no one best pattern: much depends upon the interests of the pupils, upon the teaching situation, and upon unpredictable events. A teacher should feel free to modify any unit—re-arranging the topics, adding material, and deleting material.

It is important that there be variety in a unit. Variety keeps interest high and provides for individual differences. Use experiments, field trips, demonstrations, model-making, and science play-writing, to obtain the necessary variety.

Different types of activities make different contributions to a science programme. Experiments and field trips provide the basic first-hand information. Study of books and pictures supplements first-hand information with information that has been gained by other people in different situations. Model-making, play-writing, and similar activities serve to organize information.

These books make use of many different types of activities in the development of the programme. The detailed sections of these Teachers' Editions suggest still more types of activities that can be used to enrich the programme.

Evaluating Outcomes

As yet, no one has discovered how to measure the truly important outcomes of a science programme. Certainly the facts of science as tested by pencil-and-paper tests are of small consequence. The important outcomes are the attitudes that pupils develop, the skills they gain, and the habits they acquire.

Evaluation of the effectiveness of a science programme is chiefly one of personal judgment. One must depend upon many small but significant signs. One may look for signs of general interest. How many pupils participated in each activity? How many children volunteered for optional activities? How many pupils brought in materials when asked to do so? How many brought in materials without being asked? How many pupils repeated science activities at home? Did pupils talk about their science experiences outside school?

Specific achievements can be used as a measure of success. What experiments were carried out? What field trips were taken? What projects were completed? What books were read?

One may look for signs of pupil growth. How many normally quiet children took active parts in class work? How many passive children took on leadership responsibilities? How many "slow" readers turned to books for information? How many pupils turned out work of improved calibre?

To measure the progress of individuals look for interest, effort, growth, and achievement. Not all children can be judged by the same standards, but if in his own way a pupil has shown evidence of each of the above, one may feel satisfaction with the results.

SPECIAL TECHNIQUES FOR TEACHING SCIENCE

Most of the teaching techniques used in other subject-matter fields apply equally well to science teaching. But when pupils begin to experiment, to perform demonstrations, to take field trips and to build models, it is obvious that a teacher must have a knowledge of some additional teaching techniques.

The majority of the activities suggested in the Exploring Science Series are direct experience activities. They are simple and they are clearly described in the textbooks. A teacher should have little difficulty in helping pupils carry them out, but if difficulties do arise, the detailed assistance given in the Teachers' Editions should quickly clear them up. The real problem that faces a teacher is not that of giving technical assistance with activities: the problem is finding ways to help pupils gain the most from the experiences.

Science education stresses a number of major goals such as the development of critical thinking and the habit of withholding judgment. The activities which pupils carry out set up the situations that permit these goals to be attained. It is in working toward these major outcomes that many elementary teachers need help.

The Problem-Solving Approach

What a child learns may be of less value to him than the way he learns it. A curious child can be led to speculate, to experiment, to check conclusions. He can be given practice in defining problems, He can be given opportunities to exercise his ingenuity. He can be encouraged to develop a critical attitude and an open mind. Such experiences are worth more to him than the bits of information he may pick up.

Elementary science is well-adapted to the problem-solving approach. The materials of science awaken curiosity: "How did this dandelion get in my garden?" "How can I connect this dry cell to an electric bell?" "Why does my dog prick up his ears when he wants to hear better?"

It must be remembered, however, that questions do not automatically become problems. A teacher may ask, "How do the people of Canada get their drinking water?" only to discover that few children care. Children are more interested in small and immediate problems: "How can fish stay under water?" Teachers should always re-examine the problems they intend to use to be sure that they have problems which challenge the pupils.

Answering Questions

It is a matter of courtesy to recognize all questions that pupils raise, whether the questions seem relevant or irrelevant, intelligent or silly. Perhaps if we could know all that goes on in a child's mind we would consider all his questions more seriously.

Recognition of a question does not mean that the question must have an immediate answer. Teachers probably answer too many questions for the good of the child. When a teacher answers a question, or selects one of the pupils' guesses as correct, there is nothing more for the pupil to do. It is better to encourage him to speculate, experiment, observe closely, and turn to recognized authorities for information to answer his own questions.

The more a teacher knows of a subject the easier it is to avoid the direct answer in favour of suggestions for finding answers independently. But when a teacher's background in a field is limited, it is still possible to make suggestions that send a pupil to experiments and to books for information—and for the answers.

A teacher must often say, "I don't know, but . . ." and follow up with suggestions for planning an experiment, or with the name of a recognized authority. There are innumerable questions that neither the teacher nor anyone else can answer. Physicists do not know why a magnet picks up iron. Biologists do not know why a bobolink migrates to South America in autumn. No one knows why the earth pulls things toward it or how a green plant produces sugar. The teacher must never be afraid to say, "I don't know." These are the words that challenge mankind. Perhaps that teacher's pupils will be the very ones to solve these age-old questions.

Experiments

Children love to experiment—to find out by "doing," as compared with learning through reading and being told. This is because children like to manipulate, they like to see things happen, there is an element of suspense involved, and perhaps they subconsciously recognize the validity of information gained this way.

Experiments in the elementary school should be informal. Problems are best stated in the words of the children. There is no place for the formalized pattern of "objective, apparatus, procedure, observations, and conclusions."

The best problems for experiments are the small problems that can be solved with simple equipment and in a short time. "Can a magnet attract a paper clip through cloth?" "Will grass turn yellow when a board is laid on it?" "Will cocoa pass through a filter?"

A number of worth-while problems arise from discussions that pupils hear at home. "Does hot water freeze faster than cold?" "Will aspirin tablets keep cut flowers from wilting?" "Is the coldest place in a room near the floor?"

Certain problems are too broad for children to solve. "Do plants need light in order to live?" "Does a fire need air in order to burn?" It would be improper to let pupils feel that they had answered such questions after two or three experiments. Instead of such problems, pupils should be encouraged to work on more limited problems. "Do bean seeds need light in order to start growing?" "Will a candle burn longer in a quart jar than in a pint jar?"

While pupils are carrying out an experiment, the teacher should refrain from influencing their conclusions. Only after the pupils begin to discuss their results should the teacher begin to raise questions that will encourage them to modify their conclusions. Perhaps the pupils have discovered that a pot of corn seedlings in a dark closet died after six days. Some of the pupils have decided that corn seedlings need light in order to live. The teacher may now suggest that the seedlings might have died anyway, perhaps because the soil was poor. She may then encourage the pupils to set up the experiment with another pot of seedlings in a light place.

Teachers are sometimes upset because an experiment does not "work". Actually, all experiments "work" in that they show that something happens or fails to happen. When an experiment does not turn out as anticipated, it is because some unconsidered factor has entered or because the expected result is wrong. But that is the fun of experimenting, not knowing what the results are going to be and trying to account for what does happen.

Field Work

The Exploring Science Series encourages field work as one of the most effective methods of learning science. Few are the units that do not suggest directly or indirectly some type of field work.

Possibilities for field work are almost endless. School buildings often have heating systems, gymnasiums, shops, kitchens, medical centres, and fire protection devices. School yards frequently have play equipment, flag poles, shaded and unshaded areas, and varying kinds of vegetation.

Near schools there are often parks, gardens, vacant lots, and fields where plants can be studied. Where there are plants there are insects and other animals. Near schools there are sometimes automobile service stations, stores, greenhouses, and other business establishments. These present many opportunities for the study of science.

Field work should be planned carefully. Children should know what they are to look for. Do crocus blooms stay closed on cloudy mornings? How is air put in a tire? These are simple, direct problems well fitted for field investigations.

Outdoor experiments make good subjects for field work. The pupils may compare the temperatures of pans of water in sunshine and in shade. They may study the effect of sprinkling water on a pile of soil.

Field work is usually more effective when each pupil has something to do with his hands. The children may collect coloured leaves. They may take the temperatures of the soil in different places. They may write the answers to questions formulated before the trip.

Techniques for handling pupils in the field are somewhat different from handling pupils in the classroom. Each pupil must have something to do and he must know exactly how to do it. One of the important differences between indoor and outdoor situations concerns the amount of talking by the teacher. Lecturing and class discussion usually fail in the field because there are so many distracting elements. These techniques should be reserved for the preparatory and follow-up lessons. Once in the field, the teacher should generally talk only with individual pupils who come up with special questions.

Science Projects

Science projects exist in such rich variety that it is possible to appeal to the many interests and talents in a class. Children who like to work with tools enjoy making models. Children who like to draw and paint enjoy making posters, charts, and friezes. Children who like to write find opportunities to write stories and plays. Children who like to collect will enjoy preparing exhibits of their science collections.

Science projects such as these encourage pupils to plan, to use ingenuity, to persist at a job until it is done. Group projects give children opportunities to work together, to share, to assume leadership. The final products are tangible evidence of accomplishment and give the children deep satisfaction.

Such projects are important in the learning process. They bring together information and organize it in easily understood patterns. Often the projects give rise to new problems for the pupils to work on.

Completed projects should be put on exhibition whenever possible. Projects may be displayed in the foyer of the school, at Parents' Nights, and at P.T.A. meetings. They may be exhibited in store windows during Education Week. Local newspapers are usually delighted to publish photographs of exhibits and the children who made them; the teacher need only call up the editor and notify him of the displays. Through projects of this kind, parents gain a better understanding of what goes on in the school programme, and children enjoy sharing their science experiences with them.

CONSERVATION EDUCATION

Elementary science should make significant contributions to conservation education. Science deals with plants and animals, rocks, soil and water, and with the scientific principles that control these natural features. Science helps meet the three general objectives of conservation education—1) to give information about natural resources, 2) to develop desirable attitudes towards the use of natural resources, and 3) to give experiences with conservation practices.

Studies of the life histories of living things give an understanding of their problems. Each book of the Exploring Science Series includes a number of life history studies, and others are suggested in the Teachers' Editions.

Interrelationships among plants, animals, and their natural environments are also important. Better understanding of interrelationships would have prevented the admission of many animal and plant pests into this country, the extinction or near extinction of many species, and the many other mistakes we have made in handling our environment. This Series stresses interrelationships in all units dealing with the natural environment.

In general, when pupils gain sufficient backgrounds of information they develop proper attitudes. Having seen a badly eroded pasture, having learned the value of topsoil and the difficulty of replacing it, they recognize the waste and the need for conservation practice. They need no indoctrination; they draw their own conclusions from the facts.

These books also show children how to practise conservation for themselves. They are encouraged to take care of their clothing and their toys. They learn to conserve heat by closing doors and windows in cold weather. They are instructed in the prevention of grass fires and forest fires. They learn how to co-operate in fire prevention about the home.

Children are also encouraged to help keep streets, roadsides, parks, and picnic grounds free from litter. Much education is needed in the proper use of one of our great resources, the beauty of the countryside. By taking pupils to places that are beautiful and then for contrast to places that have been abused, the teacher gives them training in an important area of conservation education.

HEALTH AND SAFETY EDUCATION

All areas of the elementary school curriculum must share in the responsibility for helping children learn to take care of themselves. Science is especially important since it contributes much of the informational background necessary. By broadening its goals, the teacher may use science as the basis for the health and safety programme when classroom time does not allow for two separate programmes.

These are the areas commonly included in health and safety programmes for the elementary school:

The meaning of health
Body growth and development
Nutrition
Circulation and respiration
Digestion
Elimination
Bones (including teeth) and muscles
Skin, hair, and nails
The senses
Ears, nose, and throat
Rest and relaxation
Mental health
Sanitation
Communicable diseases and their prevention

Tobacco, alcohol, and drugs
Preventing falls
Safety with tools
Preventing fires
Traffic safety
Treatment of small wounds
Prevention of sunburn
Water safety
Safety with animals
Safety with electricity (including lightning)

The Exploring Science Series provides a combined science and health programme when such a combination is desired. Most of the units in each book contain health and safety material. For instance, the fourth grade unit "Static Electricity" includes a lesson on safety during a thunderstorm. The sixth grade unit "Water in the Ground" includes several lessons on safe drinking water. In addition, each book contains one or more units dealing primarily with health and safety, which are noted at the end of each book under "The Major Topics Presented in Each Unit." Thus a complete integration of the two programmes can be carried out in a completely natural way.

The flexible organization of the books permits the emphasis to vary according to need. If the school provides a separate health and safety programme, only a minimum amount of time need be spent on repetitious material in this Series. But if the combined programme is in operation, the health and safety material may be expanded as desired. The special helps in the Teachers' Editions show how to make the most of situations that arise from working with the Exploring Science Series.

It should be remembered that the science programme cannot assume the complete responsibility for health and safety education. Health and safety instruction must go on at all times. Children need orientation in the use of drinking fountains, public toilets, and school washrooms. They must be reminded constantly about washing after playing with things that dirty their hands, after going to the toilet, and before eating. They must be encouraged to play actively and then rest quietly. Safety in the classroom and on the playground must be stressed constantly. And the whole problem of mental health—good social adjustment, self-confidence, self-reliance—should be an every-minute-of-the-day concern of the teacher.

Detailed Teaching Suggestions for Book Four

Fourth-grade pupils love experiments, demonstrations, field trips, and projects. It is sometimes difficult to persuade them to drop their science work when other things must be done.

Liberal use of direct-learning situations is in keeping with the aims of the Exploring Science Series. Such activities develop the essential background of first-hand experiences without which science means little. Discussion, reading, and telling—while having a place in the programme—are best used to supplement information gained at first hand.

Fourth-grade pupils benefit most from simple, direct types of activities. Activities that involve abstract ideas and two or three steps in reasoning serve only to confuse many of the pupils. On the other hand, there is no value in insisting that they carry out activities with which they are completely familiar. Each activity proposed should have something new for the pupils to look for.

Pupils like to repeat certain types of activities. They should be encouraged within reason. Repetition can result in increased learning if during each repetition the pupils are trying to learn something. It is a mark of special interest if pupils repeat their science experiences outside of school.

The development of critical thinking is an important outcome of a science programme. One should not underestimate the ability of children to think clearly. They are naturally more cautious in making statements than most adults realize. Too often it is the teacher herself who muddles their thinking by hurrying them into drawing conclusions and by insisting that they make unwarranted generalizations.

In their experiments pupils should be encouraged to test their conclusions again and again. They should learn not to feel satisfied with statements based on a single experience. The teacher can help them by expressing scepticism and by suggesting possible exceptions.

Verbalization is of secondary importance in the science programme. It is more important for pupils to have had an experience than to be able to talk about it. None the less, fourth-grade pupils should be developing a certain amount of verbal ability. Teachers will find that they can take advantage of the strong interests developed in the science programme to help children learn to express themselves.

Fortunately, the common phenomena of science can be described and explained with common words. No highly specialized vocabulary is needed. Pupils can talk about the "balancing point" of a lever and the "flap" on the wing of a plane without knowing such words as "fulcrum" and "aileron." The pupils who are ready to use the specialized words should be encouraged to do so, but the remaining children should not be pressed into using words they do not understand.

Exploring Science Four uses relatively few technical words. Those that are used are introduced carefully. This Teachers' Edition suggests additional words and gives directions for introducing them. In general, it may be said that pupils should be given a sound understanding of the object or condition that the word describes. Then the word is introduced and used until the pupils begin to use the word spontaneously. Not until then should one try to add it to the reading vocabulary of the children.

Individual differences make themselves sharply apparent in the intermediate-grade science programme. Pupils are beginning to leave the immediate home environment and enter into a wide variety of situations. Their experience backgrounds are far less homogenous than in the beginning grades. Thus there is a widening diversity of interests.

The range of abilities widens at the same time. Pupils are discovering and developing their special talents at an increasing rate as they find satisfaction in these talents. Pupils are sometimes regressing also. Slow readers often develop antagonisms that hinder their reading. Clumsy children, because of ridicule, shun work with tools. Insecure children retreat into the world of movies, comics, and television.

Exploring Science Four anticipates the widening range of interests and abilities. Topics have been selected to provide a greater diversity of follow-up activities. There are increased possibilities for pursuing special interests through reading, through model-making, through writing, through dramatization, and through independent work outside of school. The teacher should think of the activities described in the text as only the beginning, and should turn freely to the Teachers' Edition for suggestions that will help each pupil to develop in his own way.

Because the science background of a class cannot be predicted, each unit in Book Four starts at the beginning with basic experiences. Sometimes this introductory material is essentially the same as that used in previous books of this Series, but the activities used are different. Thus pupils who have little background are not handicapped, and pupils who have gone through the Exploring Science programme find new things to do.

In order that pupils may use Book Four without being handicapped by the mechanics of reading, the reading level of the book is kept below that of standard fourth-grade readers through the use of simple sentences, brief paragraphs, and a controlled vocabulary.

For pupils who can benefit from more extensive reading, a list of suitable books is given at the end of the discussion of each unit in this Teachers' Edition. These books are written with varying degrees of reading difficulty. They are interesting and valuable to children. Try to provide the children with as many of them as possible.

Teachers who are required to give instruction in the effects of alcohol and tobacco will find suggestions on pages 56 and 86 of this Manual for incorporating this instruction into the science programme.

SCIENCE DEFINITIONS

To facilitate the introduction of certain scientific terms—and for emphasis—they have been set in bold-face type the first time they occur in the text. These ten terms comprise the special science vocabulary introduced and developed in *Exploring Science Four.* Their definitions are starred in the list below, and the page on which each first occurs is included after the definition. Other scientific terms which appear in the text are also included in the list below; the teacher may wish to give added emphasis to these as well. The language in which all these terms are defined is language which the children will readily understand.

aileron—A movable flap near each end of the wing of an airplane. The ailerons help to balance a plane and help it to bank when it turns. (See picture on page 166.)

* **bacteria**—Tiny living plants that are found almost everywhere. They cannot be seen without a microscope. Some bacteria are useful, as are the kinds that make vinegar. Some are harmful, as are the kinds that give us typhoid fever. Most bacteria are harmless. (Page 22.)

ball-and-socket joint—A part of the body where a ball of one bone fits into a hollow of another bone. This is the kind of joint in shoulders and hips which lets you swing an arm or a leg in circles. (See picture on page 153.)

bulb—The underground part of certain plants where food is stored and which contains a bud in the centre. (See picture on page 46.) An onion is a bulb.

clay—A kind of earth made up of very tiny particles. Clay is sticky when wet, and it is hard when dry.

condense—To change from a gas to a liquid, as when water vapour changes to liquid water.

* **crystal**—A natural form taken by many minerals, salts, and other substances, such as a salt crystal or a quartz crystal. (See page 62.)

cutting—A part of a plant stem cut off to be grown into a new plant. (See picture on page 38.)

desert—A region in which few plants and animals live, often because there is little water.

* **dissolve**—To become part of a liquid, as when sugar is dissolved in water. (Page 50.)

earthworm—The common worm in soil everywhere. Also called fishworm and angleworm. (See picture on page 196.)

electric charge—A form of energy that makes an object try to move toward or away from another object.

elevator—The flap or flaps on the tail of a plane used to make the plane dive or climb. (See picture on page 166.)

energy—The ability to do work. Gasoline has the ability to make an automobile move.

evaporate—To change from a liquid to a gas, as when liquid water changes to water vapour.

female—Girls and women are females. Cows are female cattle. Does are female deer.

fertilizer—Any substance put on soil to give it the chemicals that are needed for the growth of plants.

* **filter**—A device that removes solid particles from a liquid being poured through it. (Page 52.)

glider—A type of airplane that has no motor.

gravel—A kind of earth made up of pebbles or bits of rock that are about the size of peas or larger.

greenhouse—A building with a glass roof and glass sides in which plants are grown. (See picture on page 40.)

hard water—Water in which minerals are dissolved. It is difficult to wash with soap in hard water.

insect—An animal that usually has three pairs of legs and three parts to its body when fully developed.

* **joint**—The part of a body where one bone moves on another, as the elbow joint. (Page 152.)

* **lever**—A bar that turns about a point and is used to move something else. (Page 140.)

lightning rod—A metal rod on the roof of a building which is connected to the earth. The electricity that produces lightning goes harmlessly down the rod to the earth without injuring the building. (See picture on page 121.)

loam—A kind of soil containing about one-fourth clay and three-fourths sand. It may also contain bits of decaying plants.

maggot—The young stage of certain insects such as flies. Maggots have no legs. (See picture on page 24.)
male—Boys and men are males. Bulls are male cattle. Bucks are male deer.
* **mineral**—A chemical that is found naturally in the earth. Quartz is a mineral. (Page 55.)
muscle—The part of the body that moves another part, such as the muscle in the lower arm that closes the hand. "Lean meat" is made up of muscles. (See picture on page 150.)
propeller—The whirling part on some types of airplanes used to pull or push the airplane through the air. (See picture on page 168.)
pupa—The stage in the lives of certain insects when the insect moves little but is changing inside. The pupa stage of most moths is spent in cocoons.
* **reptile**—An animal that usually has scales and changes temperature as the air around it changes temperature. Snakes, alligators, and turtles are reptiles. (Page 214.)
rudder—The part of a plane that steers it. (See picture on page 166.) Boats have rudders, too.
* **sap**—The liquid in a plant that carries food and minerals from one part of the plant to another. (Page 58.)
socket—Part of a ball-and-socket joint that is a hollow in a bone. (See picture on page 153.)
* **tendon**—A tough cord that joins a muscle to a bone. (Page 148.)
twilight—The faint light reflected from the sky before the sun rises and after it sets.
water vapour—Water that has changed to a gas.
wriggler—The young, active stage of a mosquito. (See picture on page 32.)
yolk—The yellow part of an egg.

Night Comes

PURPOSE OF THE UNIT

In the first three books of the Exploring Science Series the work in the area of astronomy has dealt chiefly with the sun—its apparent motion through the sky, the change in its shadows, the variation in the hours of sunlight, radiation of heat and light from the sun, and moonlight as reflected sunlight. In this unit we expand the concept of sunlight to show that daylight is sunlight, and that absence of sunlight gives us night. We also try to show some of the effects of the absence of sunlight.

For the first time in this Series, we introduce the abstract idea that the earth is a rotating ball. This idea is used as a possible explanation of the regular succession of day and night. However, it is not given as a proven fact, rather as a generally-accepted theory. This procedure is in accord with our aim of developing a scientific attitude in pupils.

The coming of night brings about important changes in physical conditions and in the activities of living things. Thus a study of these changes places this unit among those units which deal with the interdependence of living things and their environment.

The unit also encourages pupils to make independent observations, using their senses of hearing, smelling, and feeling which too few people exercise adequately for a rich life. This, too, is in keeping with our aim of developing the whole child.

PREPARING FOR THE UNIT

This unit is best taught while the weather is mild so that pupils will not be discouraged from noting what happens outdoors. The unit has been assigned to the fall season because nightfall comes earlier in the fall than in the spring, and because there is more opportunity for follow-up.

Aside from a globe and a few other items, no special materials are required for this unit nor is any special preparation required.

Some enrichment materials may be available. Pictures of night scenes, of nocturnal animals, and of dew and frost, together with diagrams showing the possible causes of day and night, are useful bulletin board materials. The section on artificial light can be enriched with pictures and with models of lighting devices.

List of Materials

Candles
Globe
An orange or apple
A pin
A pencil

TEACHING THE UNIT

Not many classroom activities are possible with this unit. The success of the unit depends upon how well the children are encouraged to carry out activities themselves at home. The children should be stimulated to make observations and to keep records of their observations. If the teacher will also be alert to things happening outdoors at night, and if she will describe these experiences with enthusiasm, the children will be much more apt to become interested. Perhaps no other motivating factor is more valuable than enthusiasm on the part of the teacher.

Pages 4–5

These are discussion pages that can be used to introduce the unit. They deal with some of the things that can be seen or otherwise sensed at night.

What lights can be seen at night? Which ones are natural? Which are man-made? Pupils will probably mention stars and the moon. They may mention northern lights, lightning, and lightning beetles. Among the artificial lights they will probably name various electric lights—house lights, street lights, auto lights, airplane lights, and flashlights. They will probably name bonfires and campfires, and the glow of cigarettes and cigars. They may think of luminous watches and luminous switches.

What activities do people carry out at night? What games do they play? What work do people do at night? Are there people who have jobs because it is night?

What animals are active at night? At this time do not develop this idea further than the pupils' experience permits, because the activities of nocturnal animals will be considered in more detail later.

What makes it night? Let the pupils discuss this problem as far as their experience permits, and use the rest of the unit to give a solution to the problem.

Pages 6–7

These pages review the concept of changing shadows introduced in earlier grades; page 7 emphasizes the increasing length of shadows as sundown approaches. Carry out the first activity during a sunny afternoon. Suggest that the pupils carry out the second activity at home when they can watch the shadows as the sun nears the horizon.

Pages 8–9

These pages are self-explanatory. They describe what happens on a typical afternoon as the sun goes down. The important idea for the children to grasp is that darkness is a result of shadows, and that the sun is still shining even though people may be standing where they cannot see the sun directly. Call the attention of the children to the sunlight on the clouds in the picture on page 9.

Encourage the children to look for similar conditions at sundown on clear afternoons. Ask them to tell about their observations. Some children may be able to see sunlight on tall buildings after they themselves are in the shadow; others may be able to see sunlight on the tops of hills or mountains. Ask them to make pictures of a series of observations made in late afternoon.

Page 10

If the children have grasped the idea of the sun shining after it is no longer visible to people in a certain locality, they will probably grasp the explanation of twilight with little trouble. If they can see the effect of clouds in producing twilight but cannot understand how dust might produce it, choose a time when sunlight is entering a window of the classroom, pull all the other shades and dust an eraser vigorously in the beam of sunlight. The children will be able to see the increased light that is reflected through the room.

Encourage the children to time the length of twilight. Their estimates will vary depending upon when they decide twilight has ended. The time will also be affected by cloud conditions.

Encourage the children to make observations of the appearance of things after nightfall. **What can you see? Can you distinguish colours? How does a dark red object look? How does a light blue object look? Are there shadows? Can you see the same things on cloudy nights as you can on clear nights?** Ask them to make pictures of their observations. It will probably surprise the pupils to discover that colours are not visible on a dark night—that everything is seen in shades of gray.

Page 11

Begin this activity by taking a series of temperature readings through the day. **How do the readings vary from the time school starts until it ends?** Ask the children to continue the series of readings after they go home.

For best results do not put the thermometer in direct sunlight, but rather shade it with something during the time sunlight might fall on it. Thus a record of *air* temperatures—not the temperatures of an object warmed by sunshine—is taken.

For contrast, it might be well to take a series of readings on the south side of the school where the sunlight falls on the thermometer. The children should realize, however, that the air may not be as warm as the thermometer under these conditions.

Pages 12–13

The coming of night brings many changes. Review with the children the causes for the formation of dew and frost. See pages 93–112, *Exploring Science Three.* Encourage them to go out with flashlights after sundown and look for dew and frost. Ask them to make pictures of dew-covered and frost-covered spider webs and plants as they see them in the morning. Ask them to tell about their experiences with dew and frost.

Each region has a number of nocturnal animals. The ones shown on this page are, from top to bottom and clockwise, a bat, an owl, a moth, a skunk, and a rabbit. Other animals that might be seen or heard are deer, crickets, deer mice, night hawks, toads, several kinds of grasshoppers, and night crawlers. Ask the children to tell about the animals they have seen or heard at night. Encourage them to read about the habits of some that they have identified.

Nothing is said on these pages about the changes in plants as night comes, but many plants do react to the decreased light or the decreased temperature or both. Some flowers, such as dandelions, close at night. Ask the children to visit their flower beds at night to see if any flowers have closed. Some plants, such as the clovers in lawns, fold their leaves on cold nights; ask the children to look for these plants. Ask them to make pictures recording their observations.

Pages 14–15

One of man's reactions to the coming of night is to find some way of producing light. Children enjoy studying the history of some of these efforts. They can make fat-burning lamps of modelling clay, each being a saucer-shaped dish with a handle at one side. On the side opposite the handle there was usually a notch something like the spout of a pitcher (the notch is not shown on page 14) for the wick. The wick can be a roll of cotton cloth. Vegetable oil or animal fat can be burned, the latter being melted and poured into the dish to harden. Since there is always some fire danger with open lamps of this type, use caution.

The pupils can also make candles by pouring melted paraffin into moulds. Always be careful when melting paraffin, because if it evaporates it makes an explosive gas. The paraffin should be heated until it barely melts and then poured into a mould.

They can prepare an exhibit of other types of lighting devices, using things they bring from home together with pictures and drawings they have copied from books. Such an exhibit arouses considerable interest.

Pages 16–17–18–19

These pages attempt to explain through diagrams and models why night and day follow each other in regular sequence.

The explanation given is the one usually accepted today. However, it is desirable to explain to the pupils that until man can get far away from the earth, so that he can see it as a whole, he cannot positively prove that this explanation is the correct one. The pupils might be interested in hearing about some of the older theories, now often called myths, such as the belief of the ancient Greeks that the sun was carried daily across the sky in a chariot driven by Apollo. Encourage the pupils to discuss some of these theories.

Page 20

To make this page more effective, review the work about the moon (*Exploring Science Three,* pages 14–17), in which the cause of moonlight is explained. It may be desirable to set up the same model that was used in Book Three. The model will help the pupils understand better the reasons for day and night on the moon.

Summary Questions

1. Shadows grow longer in the afternoon because the sun is lower in the sky.

2. Twilight is sunlight that is reflected to the earth from dust in the air and from clouds.

3. We believe that we have day and night because the earth seems to be a ball which spins around in sunlight, presenting first one side and then the other to the light.

4. When it is night here it is daylight on the opposite side of the earth.

5. When night comes, the temperature usually drops; moisture often condenses from the air; there is less light; some plants and animals become less active while others become more active.

6. The animals listed on page 13 plus any others the children have seen may be named in answering this question.

7. The types of artificial light mentioned on pages 14–15 plus others within the pupils' experience may be mentioned as answers.

Follow-up

On occasion throughout the remainder of the year the children should be encouraged to make observations at night, comparing conditions at night through different seasons.

POSSIBLE LEARNINGS

The earth seems to be round like a ball.
We believe the earth spins round.
As the earth spins, part of it is in sunlight and part is in shadow, thus causing day and night.
Temperatures usually drop when night comes.
Moisture often condenses from the air when night comes.
Many animals become more active when night comes.
Man has invented many kinds of light to be used when night comes.

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Books

Patterns in the Sky. William Reed. George J. McLeod: Toronto, 1951. 125 pages.
Here are charts, facts, and mythology.

Picture Book of Astronomy. Jerome Meyer. Ambassador Books: Toronto, 1945. 36 pages.
A direct approach, with simple, graphic language and coloured illustrations.

Worlds in the Sky. Carol and Mildred Fenton. Doubleday: Toronto, 1950. 96 pages.
Simple, yet enjoyable. An outstanding book in its field. Well illustrated.

You Among the Stars. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1951.
A simple book with helpful illustrations for the curious child.

Films

What Makes Day and Night. Young America Films.
Explains the causes of day and night.

SG-45 This is the Moon. Ontario Department of Education.
Excellent enlarged telescopic views show clearly the detail on the surface of the moon.

Fun With Stars. Popular Science.

Insects That Carry Disease

PURPOSE OF THE UNIT

Of all the insects, none have brought more hardship and suffering to man than common houseflies and certain species of mosquitoes. History is filled with accounts of their ravages.

It is only in recent times that the role of flies and mosquitoes as disease carriers has been well understood. Consequently, control of these insects has not been attempted until recently, and the control measures are only partially successful at best. Some regions have no control at all.

In order to gain control of these insects there must be whole-hearted co-operation on the part of a population. To have co-operation there must be understanding. It is the duty of schools to provide the understandings that will insure proper co-operation.

People must know how insects carry diseases. In the discussion of the housefly in this unit, the term "bacteria" is introduced. It is unlikely that children at this level can gain complete understanding of bacteria, but they begin to acquire some knowledge of them. They can be told that bacteria are very tiny and very numerous. They can realize that a few kinds of bacteria can live in our bodies and that the poisons given off by certain of these kinds may make us sick.

It is to be hoped that teachers will avoid the use of those silly stories that portray bacteria as vicious little animals. Bacteria are neither vicious nor are they animals; they are more like plants than animals. Most of them are harmless. Many kinds are useful. Only a few kinds are harmful.

More attention is given in the unit to the transmission of disease by houseflies than by mosquitoes. Houseflies are common and the diseases they carry are widespread; in the over-all piecture they are the more dangerous. And there is no value in a child being frightened every time he is bitten by a mosquito.

For complete co-operation in fly- and mosquito-control measures, citizens should know the life cycles of these insects. Frequently, it is easier to control the early, harmless stages of an insect than to control the dangerous adults. This unit stresses the life history of both insects.

The subject-matter content of this unit has its place in the biology sequence of an elementary science programme as well as in the health education sequence. The life histories and habits of these insects are typical of those of hundreds of similar species. Concepts developed at this time permit ready comparisons and quicker understandings when more advanced study of insects is introduced.

Specifically, this unit builds on the concepts developed in earlier grades, particularly the units "Caterpillars" and "Grasshoppers" in the first and second grades respectively. Later units, such as "Life in Quiet Water" in the fifth grade, build upon this one.

PREPARING FOR THE UNIT

There are advantages to studying this unit in early fall. Flies have reached the climax of their numbers and they are easily available for study. Woodland pools at this season are usually well stocked with wrigglers. During the weeks just preceding the study, the children will have had many experiences with flies and mosquitoes, and the experiences will still be fresh in their minds. Such experiences may be used to initiate the study of the unit, particularly if there have been some attempts at insect control in the community.

Very few materials are needed. Various glass jars are used for raising fruit flies and mosquito wrigglers. Low-power hand lenses are important. A high-power hand lens, such as a 5-power or 7-power, is helpful although harder to use. A low-power miscroscope or a microprojector has value in the study of the insect parts.

In terms of preparation, a teacher should look for places to collect mosquito wrigglers and fruit fly larvae. The wrigglers may be found in shaded pools, in rain barrels, or in almost any standing water of shallow depth. Fruit flies may be found around a fruit store. A basket of ripe grapes or a few ripe bananas will also attract these small flies.

List of Materials

Hand lenses
Milk bottles or quart jars
Corn meal
Hot-plate
Paper towel
Grapes or bananas
Insect sprayers and sprayers for display and study
Screw-cap jars
Gallon jar or fish bowl
Square of cheesecloth
String

TEACHING THE UNIT

Houseflies are treated first in this unit because the children have usually had more experience with houseflies. However, if conditions have awakened an interest in mosquitoes, the unit may be rearranged to study mosquitoes first.

The term "bacteria" is introduced in this unit on page 22. It is well to discuss this word at length so that proper concepts are developed. It may be necessary to break down some wrong impressions associated with this word.

Page 21

This picture can be used to set the stage for the study of houseflies. **Note the open window. What are the flies doing? Have you ever seen flies on food? What kinds of food did the flies seem to like best? What did the flies do while they were on the food?**

Where have you seen flies in large numbers? What seemed to be the reason for so many flies being there?

From the discussion try to make the pupils conscious of the fact that flies are attracted by food, by spoiling things, and by filth. It is the combination of these attractions that makes flies dangerous to us.

Pages 22–23

Study of dead and living flies makes this section most effective. The pictures should be used to show the children what to look for.

Flies may be collected in windows by putting a jar over them and then sliding a card between the window and the jar. The flies may then be killed by putting into the jar a bit of cotton soaked in carbon tetrachloride or chloroform.

The children should wash their hands thoroughly after handling houseflies.

The flies should first be viewed with hand lenses of low power. Then, if higher-power lenses are available, the children may examine the flies at higher magnification. A low-power compound microscope is useful to show the hairs and the dirt on the legs of the flies. A microprojector can also be used to produce on a screen a greatly magnified view of a fly's leg.

The eating habits of a housefly can be observed by putting a live fly in a drinking glass that is inverted over a drop of milk or a bit of sugar. The mouth parts of a dead fly can be seen with a hand lens.

Some discussion of the disease cycle is now in order. A fly feeds on something that contains disease bacteria. In communities where there are outside toilets, the flies frequently feed on human excrement. The fly then enters a home and alights on some food. As it walks over the food, bits of dirt containing bacteria may dislodge from its feet. The fly may also deposit bacteria as it moistens the food with its tongue or as it excretes its own body wastes on the food. A person may eat this food. Then the bacteria may multiply rapidly in his body, and give off poisons that make him sick.

Pages 24–25

These pages give the life cycle of the housefly and the fruit fly. The latter has been included because it is easier to raise than the housefly. When introducing the term "pupa," explain that although the insect seems quiet it is changing inside.

A milk bottle is somewhat easier to use for raising fruit flies than is the jar suggested in the text. Where local ordinance does not forbid such uses of milk bottles, it is recommended that one be substituted for the jar. It is well to wash the bottle or the jar with soapy water to avoid contamination with undesirable moulds. (In preparing the corn meal, use about three parts of water to one part of corn meal.) Sometimes a jar becomes contaminated despite such precautions. It is easier to discard the contents and start afresh than it is to try to salvage the developing fruit flies.

To enrich the study of the life cycle of flies one may buy or prepare charts and exhibits of the stages of housefly life histories.

Page 26

The children can see the claws and the sticky pads on the feet of houseflies with a high-power hand lens or a low-power miscroscope. They may watch a fly climbing over the interior of a glass jar to see the sticky pads in use.

If the children handle the flies, direct them to wash their hands afterwards.

Page 27

Children should learn something about fly control measures and they should practise some of them. They can help by keeping covers on garbage cans, by keeping screens in windows, and by closing screen doors. They may also "swat" flies that enter their homes, and they may even participate in spraying to kill flies.

The children may prepare an exhibit of things that are used to help keep houseflies under control. They may collect such things as fly swatters, fly traps, fly poisons, sticky fly paper, and spray containers. They should be encouraged to study the directions given with some of these devices, to discuss the limitations and advantages of each, and to prepare posters that make this information more meaningful.

Pages 28–29

These pages introduce the adult mosquito. (Shown here is the Anopheles mosquito which can transmit malaria.) They take up first the interesting mouth parts that are so well adapted for taking in liquid food. Help the children to interpret the diagram on page 29 so that they realize that the cutting and piercing mouth parts are surrounded by the sucking tube.

Pupils should notice the other features of the mosquito, such as the number of legs (six) and the number of wings (two). The exact function of some of the sense organs labelled "feelers" and "tasters" is not thoroughly known. The organs are certainly sensitive to touch. They seem to have other functions also.

Live mosquitoes may not be available for study. They are fragile and not easy for small children to capture intact. Some adults may emerge from the wrigglers and pupae that are kept in a jar. These may be studied with a hand lens.

Pages 30–31

The highly-publicized habit of feeding on blood is probably uncommon among mosquitoes as a whole. Certainly, the males feed exclusively on plant juices if we can believe the best authorities, and many females must never taste blood. It is the effect of the mosquito bites on humans that makes the blood-sucking habit seem so important to us.

The irritation of a mosquito bite is due to a liquid pumped into the puncture by the mosquito before it begins taking blood. This liquid prevents the blood from clotting; without it, the mosquito would have difficulty sucking up the rapidly-clotting blood.

The practice of injecting this anti-clotting liquid sometimes spreads diseases. Malaria is the most common of the diseases spread by mosquitoes in this country. This disease is caused by tiny animals, not bacteria, that live in the blood and break down the red corpuscles. A mosquito that feeds on the blood of a person infected by malaria takes up some of these tiny animals and injects them into the blood stream of other people along with the anti-clotting liquid.

Fortunately, not all mosquitoes can transmit malaria. The Anopheles mosquito, shown in its characteristic pose on page 31 at the left, is the malaria-transmitting mosquito. And because of the use of screens and mosquito-control measures, fewer Anopheles mosquitoes are becoming infected with the tiny animals that cause malaria. (The mosquito shown at the right is the generally harmless Culex mosquito.)

Pages 32–33

Mosquito wrigglers and pupae may be found in shallow pools, rain barrels, and ditches containing stagnant water. Sometimes the egg rafts may be seen. Collect these stages by dipping into the water with a can or jar. Keep the specimens in the same water in which they were found, because this water contains the food they need.

If possible, give each pupil a glass jar with some wrigglers in it so that he may become thoroughly acquainted with them. Not all forms will look and behave exactly like the ones pictured here. The ones shown are Culex mosquitoes, a common and harmless form.

Some pupae may have been collected with the wrigglers and some may develop from the wrigglers. These pupae are interesting because they are able to swim about; the pupae of most insects are quiet.

Adults will emerge from the pupa stage after a few days. Keep a cloth tied over the mouth of the jar to prevent them from flying away.

Page 34

Screens for doors and windows represent an important means of preventing the spread of diseases by mosquitoes because they help to prevent the mosquitoes from getting to both the sick and the healthy.

Mosquito sprays have become increasingly important in recent years. The children should have an opportunity to study the directions given with these sprays because some of them should not be used near food and others should not be inhaled. Study as many types as possible.

Summary Questions

1. The pupils should describe the four stages of these insects as outlined on pages 24 and 32. They should also tell something of the habits of the insects in each stage.

2. Houseflies eat many of our foods, and in addition they eat rotting things and animal wastes. Adult flies suck up food with their tongues. Mosquitoes eat plant juices, and the females also drink blood. Adult mosquitoes suck up food through their hollow mouth parts. Mosquito wrigglers feed on tiny living things in the water.

3. Adult houseflies and mosquitoes have six legs and two wings.

4. A housefly has a large, cushion-like mouth part that is pressed on the food while it gives off liquids that dissolve the food, after which the liquid food is sucked up. A mosquito has a long sucking tube within which are piercing parts that puncture the plant or animal that is to be fed upon.

5. Houseflies have both claws and sticky pads on their feet, and these parts enable them to walk on both smooth and rough surfaces at any angle.

6. Houseflies may carry disease bacteria to our food. Mosquitoes may carry the blood of sick people and give us the disease when they bite us.

Follow-up

Fruit flies and mosquitoes may be raised through to maturity and then the adults may be fed to toads or frogs in terraria.

If fly- or mosquito-control measures are used in the community, it may be possible to study the procedures used. Sometimes field trips are possible. Sometimes public health authorities are willing to speak to the children. There are also films and sets of slides that deal with the subject; these may be available through the public health authorities. See the BIBLIOGRAPHY at the end of this discussion.

Some accounts of insect control measures, such as those used to make construction of the Panama Canal possible, are excitingly written for children.

Certain children may like to make charts and posters dealing with the anatomy of houseflies and mosquitoes and showing the methods by which these insects transmit disease.

POSSIBLE LEARNINGS

Houseflies and mosquitoes go through four stages in their life cycles.

The larva or maggot stage of houseflies is often spent in the wastes of animals, including those of man.

Houseflies feed on animal wastes and human food, often carrying bacteria-filled bits of the former to the food.

Bacteria are very tiny and very numerous. Some of them live in humans and give off poisons that harm humans.

We can help to prevent the spread of diseases by houseflies by destroying the places where they breed, by keeping them from our food, and by properly disposing of our body wastes.

Immature mosquitoes live in water.

Mosquitoes feed on plant juices: only female mosquitoes feed on blood.

Some mosquitoes transmit certain diseases when they feed first on sick people and then on people who are well.

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The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Field Book of Ponds and Streams. Ann Morgan. McClelland and Stewart: Toronto, 1930. 448 pages.

Contains information about the life histories of mosquitoes, horseflies, black flies, and other insect pests.

Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed.

Valuable for general reference and as a teaching guide. An up-to-date natural history library in one volume.

Insect Friends and Enemies. Bertha Parker and Robert Gregg. Copp Clark: Toronto, 1941. 35 pages.

The relation of insect life to man.

Our Insect Friends and Foes. William Du Puy. Winston: Toronto, 1940. 284 pages.

Gives the features and habits of insects.

Films

Cleanliness and Health. Coronet.

The presence of dangerous tiny organisms all around us is demonstrated, and the importance of cleanliness is soundly established.

House Fly. Encyclopaedia Britannica Films.

Shows the fly as a disease carrier and methods of control.

The Mosquito. Encyclopaedia Britannica Films.

Life cycle of the mosquito and methods of control.

Your Health: Disease and Its Control. Coronet.

How harmful microbes are carried and spread; and how they can be combated.

Growing Plants Indoors

PURPOSE OF THE UNIT

No study of reproduction is complete without reference to vegetative reproduction of plants. This unit on house plants gives numerous experiences with propagation by cutting, slips, and bulbs. As part of the reproduction sequence, it builds on the first-grade unit "Planting Seeds" and the third-grade unit "Travelling Seeds."

Plant structure and physiology is touched upon, adding to knowledge gained in earlier grades. Emphasis is given to the role of factors of the physical environment, particularly those of sunshine and humidity, building on concepts developed in the third-grade units "Water in the Air" and "Sunshine."

The unit calls for much individual participation. Thus opportunities are provided for learning through manipulation and first-hand observation, long recognized as important in science education. All pupils, whether good readers or not, benefit from this type of programme.

Many pupils will be able to apply their learnings to home situations, thus providing for the desirable interaction between in-school and out-of-school experiences. Some pupils may be able to have their own plants at home and they may develop healthy hobby-interests as a result. A few, through their visits to florists and greenhouses, and through the resulting interest in plants, may find their life work here.

The plants produced as a result of this unit have several possible uses. Some of them should be kept in the classroom to brighten it and make it a happier place. The children may like to take some of them home for presents. A few will be needed for experiments later in the year. Others may be given to other classrooms that have none.

PREPARING FOR THE UNIT

The best time to start plants for indoors is in the fall before the first frost. It is recommended that this unit be studied during that period.

A plentiful supply of cuttings from one or more kinds of plants is needed. Window boxes, porch boxes, and flower beds at this season are filled with desirable plants. Owners are usually generous with cuttings when the prospect of frosts is in the immediate future. If a source near the school can be located, the pupils may be taken to collect the cuttings.

Less common house plants can be located at the homes of friends or purchased from greenhouses or florists. Children will also bring plants from home once they have become interested in the subject.

Wild plants usually do not do well indoors in winter. When air is heated it tends to become drier. Woodland and common field plants are not fitted to hold moisture in dry air. They dry up and die.

Bulbs may be purchased from florists and seed stores. This unit calls for narcissus bulbs because they require less care and will grow under more difficult conditions than most other bulbs. However, other bulbs such as hyacinths, early tulips, and Dutch iris may be used.

Small glass jars are excellent for starting cuttings in water. Tin cans with holes punched in the bottoms may be painted and used as flower pots. Standard clay flower pots are often donated by parents. Glass fish globes serve for winter gardens.

The class should have a generous supply of soil. A bushel or so of garden soil should be on hand. Sand is useful for starting cuttings. Rotted leaves or woods soil is needed for some types of winter gardens. Gravel is needed for growing narcissus bulbs.

List of Materials

Half-pint jars such as baby food jars
Vases or glass jars of assorted sizes
Pots for plants (tin cans may be used)
Sand
Garden soil
Thermometers
Quart glass jars with tops
Fish globe or gallon glass jar
Pebbles
Cuttings of coleus, wandering Jew, or philodendron
Cuttings of geraniums
Plants for a terrarium
Narcissus bulbs

TEACHING THE UNIT

This is a flexible unit. Although the suggested introduction calls for the slipping of coleus plants, the pupils may begin with other plants such as philodendron or wandering Jew (which probably receives its name from a crude analogy between its habit of growth and the fable of the wandering Jew). The unit may begin with the reproduction of geraniums if interest and facilities make this beginning seem desirable. The production of blooms from bulbs may be delayed until later in the year.

Page 35

The introduction to the unit will depend much upon the local situation and upon the experiences of the pupils. This first page may be used to set the stage if a more realistic situation does not present itself.

This first page may be used late in the unit to review the children's knowledge of some common house plants. The plants shown, are, from left to right: philodendron; daffodils; geranium; snake plant or sansevieria; and in the hanging pot, strawberry begonia.

What is the girl doing? What is the name of the plant she is watering? Who have geraniums at home? What colours are they? Do you know names of any of the other plants? Who has some of them at home? What other plants do you have at home?

Would you like to start some plants for the schoolroom? Study the next pages to see what is needed.

Page 36

Ideally, to make the work of this page most effective, each pupil should collect a cutting, bring it to the schoolroom, and put it in his own jar of water for rooting. Later he should transfer it to a pot of soil. If it is impossible to take the children to collect slips, the teacher may bring in an adequate number and distribute them to the pupils. However the pupils are denied part of a worth-while experience if they do not collect their own. It is also possible for the teacher to bring in a few slips for use as a class project, but again the pupils are denied valuable experience.

This page suggests the use of coleus slips but other plants may be used. Wandering Jew is equally satisfactory.

After the pupils have observed root development for a week or so, they may transfer the cuttings to pots of soil. The children may use tin cans for pots, first punching holes in them and then painting them. These potted plants make good presents for the mothers of the pupils.

Page 37

This page shows two other plants that develop roots from cuttings in water. The plant at the left is wandering Jew, the other is philodendron. It is well to try at the same time different kinds of house plants so that the pupils can make comparisons and draw their own conclusions on a broader background. If at all possible, bring in some twigs of willow; these develop roots very satisfactorily in water.

Pages 38–39

Many plant cuttings are rooted in sand instead of water. Geraniums are easily propagated this way and will bloom in late winter if started in early fall. Begonias are also rooted in wet sand. A glass jar inverted over each cutting helps to maintain a higher humidity, thus keeping the cutting from drying out.

Pages 40–41

By all means take the class to visit a greenhouse if this is possible. Let the children plan the trip. They may formulate the questions they plan to ask, questions like those on page 41, and they may appoint individuals who are to ask the questions. They may also be interested in finding out the names of plants being propagated at the time, and the plants that are planned for Christmas and Easter.

Do not expect the children to learn the names of a great many plants. The purpose of the trip is chiefly one of finding out how plants are propagated and what physical factors must be controlled. Let the children identify the plants they know from experiences at home or at school, and give them the names of such others as interest them, but do not demand memorization of plant names.

Most greenhouses are kept warm by steam heat or by hot water heat. Look for the heating plant. All make use of the heat in the sunlight that falls on them in the daytime. Temperatures are usually controlled carefully, some greenhouses being kept from 60 to 70 degrees for plants that need warmth, such as roses. Other greenhouses are kept much cooler, about 50 degrees, for plants such as iris and daffodils. If the greenhouses become too warm, as they may on sunny days, ventilators in the roof are raised to let the warm air escape.

The children will quickly notice that hoses are used to water the plants and to wet down other surfaces so that evaporation keeps the air moist. The children will notice several indications of the high amount of moisture in the air. They will experience the "feel" of dampness in the air, the fogging of cold glasses if the trip is taken in winter, and the presence of moisture on the cooler windows of the greenhouse.

Page 42

This experiment illustrates the "greenhouse" heating effect of sunlight. Sunlight heats things through glass, but the heat does not escape rapidly through the glass. Numerous variations are possible, such as putting the jar and the thermometer in shade and then in sunlight.

Page 43

This experiment reviews and expands some of the work done in earlier units on evaporation. It leads toward an understanding of the experiences suggested on the next two pages. The concept to be developed here is that moisture evaporates into the air, and in a closed space, does not escape but keeps the air full of water vapour so that further evaporation stops. Plants in such a closed space, therefore, do not lose much water by evaporation.

Pages 44–45

Winter gardens are always popular. Where evergreen or dense woods are readily accessible, one may build up a winter garden of the type shown. The best species are such evergreen forms as partridge berry (with its red fruits), goldthread, Christmas fern, and most of the mosses. A seedling evergreen tree will also do well.

Besides the deep woods types, other forms of winter gardens may be established. However, plants that need bright sunlight will usually become "spindling" indoors where there is less light.

Winter gardens containing house plants often do well. African violets do well in them, as do small begonias and small house ferns.

Sometimes winter gardens develop mould. When this happens, open the container and expose the plants and the soil to sunlight for a few hours. Then add a little water and close the container again. If this does not stop the mould, it may be necessary to discard the contents, wash the container with hot soapy water and replant it with new plants in fresh soil.

These pages show a glass fish bowl being used for the winter garden. Other containers may be used. Gallon paste or pickle jars are serviceable. Rectangular aquariums with glass covers are excellent; the aquariums need not be watertight. Even cracked or leaky aquariums may be used.

Pages 46–47

A number of flowering bulbs may be forced into bloom. Paper-white narcissus are probably the most successful in the difficult conditions presented by the average schoolroom. If at all possible, try to keep the bulbs in a cool, light place, such as an unheated storeroom, until the buds have formed. Then bring them to the schoolroom.

Most other spring flowering bulbs must be started in cool, dark places until the root systems are established. Then they should be kept in a cool, light place until the buds are developed.

Sometimes teachers can obtain enough bulbs so that each child may plant one. When this is done, there should always be extra bulbs planted so that those which fail to bloom can be replaced. Paper-white narcissus bulbs flower about four weeks after starting.

Page 48

The strawberry geranium, the begonia leaf cutting, and the life plant leaf illustrate additional ways plants propagate. Others, such as strawberries, raspberry canes, potato tubers, sweet potatoes, and the like may also be shown to the pupils.

Summary Questions

1. By using slips and cuttings, by planting bulbs, by planting the ends of runners, by using the leaves of some plants.
2. Plants have roots below ground, they have leaves, stems, flowers, and fruits above ground. There are exceptions to this statement which may be brought to the attention of the pupils as conditions permit. For instance, some plants have aerial roots; poison ivy has roots that enable it to cling to the bark of a tree. Many plants such as quack grass and potatoes (potato tubers are modified stems) have underground stems.
3. Sunlight contains energy which warms things that the sunlight falls on. The sunlight warms the soil and other things inside a greenhouse. Steam and hot water are used for heating the greenhouse at night and on very cold days.
4. Greenhouses have temperatures better suited for many plants than the temperature of our homes, and the air contains more moisture.
5. The air in a winter garden is moist because water is evaporated from the soil and from the plants, and because the water vapour cannot escape.

Follow-up

The care of the plants started in this unit represents valuable follow-up of the learnings introduced. And, of course, as new plants are encountered through the year, they may be experimented with in the same fashion.

The trip to the greenhouse may also be repeated once or twice. Greenhouses are very interesting just before Christmas and Easter.

Classroom propagation of spring flowering bulbs is best done in later winter. When spring comes, trips to see these same plants in bloom help to apply and reinforce the learnings resulting from experimenting with bulbs.

POSSIBLE LEARNINGS

New growths at the ends of stems often root when placed in wet sand or water.

The leaves of some plants will root when placed in wet sand.

Some plants reproduce by means of runners.

Some plants can grow well at room temperatures in dry air.

Some plants need much moisture in the air if they are to grow well.

Sunlight warms the surfaces on which it falls.

The air in containers can be kept moist by providing water to evaporate and by keeping the container closed.

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Audubon Nature Bulletins. Prepared and published by National Audubon Society: 1000 Fifth Avenue, New York 28. 4 pages each.

Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

Cornell Rural School Leaflets. Cornell University. Thomas Allen: Toronto.

The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Golden Treasury of Natural History. Bertha Parker. Musson: Toronto, 1952. 216 pages.

Contains interesting background information for the teacher.

Out of Doors in Winter. Clarence Hylander. Brett-Macmillan: Toronto, 1943. 142 pages.

Teacher will find help on evergreen and deciduous trees.

Plants in the City. Herman and Nina Schneider. Longmans, Green: Toronto, 1951. 96 pages.

A good book for parents and children on raising house plants as well as out-of-door plants. Well illustrated.

Films

SN-139 Wonders of Plant Growth. Ontario Department of Education.

Children grow plants from bean and squash seeds, the stem of a geranium, the leaf of a succulent, and the root of a sweet potato plant.

Things That Dissolve

PURPOSE OF THE UNIT

Solutions are as much a part of our environment as are air and plants and animals. Water, which is so important in our lives, almost always has something dissolved in it. The ocean is a great solution of salts and other minerals. Rivers contain minerals in solution. Hard water is "hard" because of the minerals dissolved in it.

Much of our food is in solution. If it is not soluble in water we digest it and make it so. Otherwise it could not pass into our blood. The blood itself contains dissolved substances. Plants, too, can take minerals from the soil only in solution, and their sap is water with substances dissolved in it.

An understanding of solutions is essential for interpreting the things that go on around us. Much of the work in the remainder of this Series is based on concepts developed here. Plant and animal physiology, geological processes, and chemical changes all demand a knowledge of solutions.

The activities of this unit provide opportunities for all pupils to participate and to learn by doing. The principles are applied immediately to situations within the experiences of the children so that they will recognize the significance of what they have been doing.

The activities suggested are the kind that pupils may repeat at home. Pupils should be encouraged to carry out experiments by themselves because these will add immeasurably to their backgrounds of experiences.

PREPARING FOR THE UNIT

Little preparation is needed for the unit aside from collecting materials. It is well to collect the materials beforehand so that there will be no delay in studying the topic.

It is recommended that a large number of substances be collected for the experiment which tests solubility. These may be stored in screw-topped glass jars that are distinguished by paper labels. Suggested substances are: sugar, table salt, Epsom salt, baking soda, tea, coffee, cocoa, clean sand, coal, flour, corn starch.

It is fun to make lemonade as an introductory experience. A dozen lemons will make enough lemonade for 30 pupils to taste both with and without sugar. Cake-colouring tablets make very pretty solutions that may be used to colour lemonade and other drinks. Easter egg dyes and cloth dyes also make pleasingly coloured solutions. Indelible pencils dissolve and make a type of ink.

Besides the dyes, there are a number of other soluble preparations. So called "plant foods," which are mixtures of minerals needed by plants, are soluble. There are inks that can be prepared from powders by mixing them with water. Packages of soft-drink mixes usually contain sugar, a flavour, and a soluble dye.

The unit can be enriched by having some crystals, such as quartz crystals for display and by having samples of maple sugar for the children to taste. The children may make bulletin-board displays with pictures of the ocean, of crystals, or of sugar-making.

List of Materials

- Lemons
- Sugar
- Knife
- Spoon
- Pitcher or large bowl
- Paper cups
- Food-colouring tablets
- Salt
- Baking soda
- Indelible pencil
- Tea
- Coffee
- Cocoa
- Candle
- Plant food
- House plants
- Plate
- Small pane of glass
- Hot-plate or other source of heat
- Epsom salts
- Drinking glasses
- Hand lenses
- Some crystals of quartz or other mineral (if possible)
- Sand
- Coal
- Flour
- Corn starch

TEACHING THE UNIT

The key word in the unit, and one that is not often in the vocabulary of the children, is "dissolve." This will not be an easy word to introduce because its meaning must develop slowly as the children carry out the activities. It will be well to save a discussion of the word until after carrying out the first activity, that involving lemonade.

The word "filter" is also a new and not common word. In discussing the word, explain to the pupils that a filter is something like a very fine strainer which lets liquids go through it but stops tiny particles of solid things.

The word "mineral" has not been used before in this Series. It too, is difficult to define, but is best developed through a child's becoming acquainted with many examples of minerals. Perhaps we will be nearly correct in saying that a mineral is a chemical found naturally in soil or rock or water.

The words "evaporate," "condense," and "water vapour" have been introduced in the third-grade unit "Water in the Air." They may need clarification when they are encouraged for the first time in this unit.

Pages 49–50

Probably no experience makes the process of dissolving more vivid than this one. Lemonade without sugar is so very sour and with sugar so very good that the pupils cannot help noticing the difference. They will notice, too, that the dissolved sugar is invisible, though taste indicates its presence.

In addition to the lemons and the sugar, it is well to have paper cups in which to serve the lemonade. They are sanitary and disposable.

Page 51

This activity is most valuable if carried out by teams of two or three pupils. Each group can be given a small glass jar or a drinking glass and a spoon. The materials to be tested are kept on a side table and the pupils help themselves to them as needed. They should prepare two lists—one of things that dissolve and one of things that do not.

The children should be encouraged to test other things at home and report on their findings. The children can add to a class list the results of their home experimenting.

The children may like to prepare an exhibit of soluble things, showing both the substances that dissolve and the solutions prepared from the substance. They should try to find out the uses of as many of these substances as possible.

Pages 52–53

Although chemists use specially prepared paper for making their filters, paper towelling is surprisingly good. Note the way the paper is folded. The teacher will do well to practise the folding beforehand.

True solutions will go through the filter. Sugar water, red ink, and cake dyes pass through. The mud in muddy water will not, but there may be chemicals in the mud that have dissolved in the water. When cocoa is filtered most of the material is stopped by the filter, but there is enough material dissolved to give the water that does pass through a tinge of brown.

Page 54

Children like to make and use secret ink. This is one very simple form of secret ink. Heating brings about a chemical change in the baking soda and the paper. A new brown chemical is formed. Talk over with the children the precautions they must take to keep from burning the paper and perhaps starting a fire.

Page 55

So called "plant foods" are sold by florists and in variety stores. Directions for using the fertilizers are given on the packages. Only small amounts of the minerals should be given to house plants at one time. Large amounts injure the plants. Be sure the children understand this.

The children can devise some experiments with these packaged minerals. Choose house plants of the same kind and in about the same state of health as judged by their appearance. Water one half of the plants with water only. Water the other half with the mineral solution according to the directions on the package. Results are usually apparent in three or four weeks unless the soil is very rich in minerals to start with.

Pages 56–57

If "free-running" salt is used for this experiment, the water will look cloudy because materials such as starch are added to keep the salt from becoming damp. The salt water may be filtered to take out these materials, or the water may be allowed to stand until the starch and other materials have settled to the bottom, after which the clear water may be poured from the top.

Bigger crystals of salt will form if the evaporation takes place over moderate heat rather than over high heat.

The application of this principle to the evaporation of ocean water should provoke discussion. Rivers and rain are continually adding fresh water to the ocean. However, evaporation is continually taking fresh water from the ocean so that the level of the ocean and the salt content remain almost unchanged.

If members of the class seem able to grasp some idea of the enormous quantity of water in the ocean, it may be explained that rivers always bring in small quantities of minerals in solution and that in theory the ocean is becoming richer in dissolved minerals. However, the ocean is so huge that man has not noticed any significant changes as yet. We do believe, though, that the present state of the ocean is due to millions of years of small yearly additions of dissolved minerals.

Pages 58–59

These are story pages for reading and discussion. Interested pupils may investigate the processes further by reading encyclopedias. The study can be enriched by having sets of pictures for the bulletin board.

Page 60

Water that comes from springs, wells, or streams almost always contains minerals in solution. This experiment will probably give positive results in any region. Really hard water will leave a distinct white deposit. Soft water will leave just a trace on the glass.

In answer to the question "How can you make it (water) evaporate faster?" the teacher may suggest using heat from a radiator or hot-air register.

Page 61

After learning that substances in solution do not evaporate with the water, the children are ready to realize that water produced by condensation is nearly pure. It would be pure if it were not for dust in the air and for certain gases that dissolve in the water.

To test the rain water for dissolved materials it is desirable to have clean rain water. Collect it in a clean glass vessel.

Pages 62–63

Carry out the directions for making the solution of Epsom salts carefully. Use water that is very hot and add the salt slowly, a little at a time, until no more will dissolve. In this way the water will take up an enormous quantity of the salt. It is important to have as concentrated a solution as possible so that the crystals will form faster. Other crystals made easily are: sugar, table salt, and copper sulphate.

Page 64

Under natural conditions deep within the earth, usually with very hot water involved, many minerals dissolve in the ground water. Then as the water cools, the minerals may crystallize out in cavities in the rocks. Thus are formed some interesting crystals. If possible, show the children some rock crystals of different kinds. Earth science collections usually contain crystals. Perhaps some people in the community have made a hobby of minerals and are willing to show their collections. Also show pictures of different kinds of crystals.

Cave formations, such as stalactites and stalagmites, are formed in a somewhat similar fashion except that evaporation produces the deposits. Minerals in the water crystallize out.

Summary Questions

1. From their experiments the children may list the substances they found would dissolve in water.

2. The children may list the substances they found would not dissolve.

3. Cane sugar is made by evaporating the water from the sap of the sugar cane. Children should be able to describe the general steps of the process. See pages 58-59.

4. The children should realize that hard water is water that has many minerals from the soil dissolved in it.

5. Ask them to describe one of the processes they used to make crystals.

6. The children should be able to tell how a filter lets solutions go through it, but does not let solid particles go through it.

Follow-up

The pupils constantly encounter solutions of one kind or another. The best follow-up of this topic is to call their attention to these solutions and to let them report on their experiences with solutions at home. When the children question whether a substance dissolves or mixes with water, suggest that they test it with a filter.

POSSIBLE LEARNINGS

Many substances dissolve in water.

When the water in a solution evaporates, the substances dissolved in the water do not evaporate.

Substances in solution pass through a filter; fine particles mixed in water do not go through a filter.

Substances sometimes come out of solutions as crystals.

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Simple experiments with photographs by the author.

Experiments in Chemistry. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1952. 152 pages.

Directions for more simple experiments for home or classroom.

Experiments in Science. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1947. 116 pages.

Contains many simple experiments involving solutions.

Science Magic. Kenneth Swezey. McGraw-Hill: Toronto, 1952. 182 pages.
More simple experiments, with photographs.

Films

Chemistry. Gateway.
Chemistry ceases to be a mystery for young children when they learn that mother is really a chemist in the kitchen.

Stopping Safely

PURPOSE OF THE UNIT

Our safety on streets and highways often depends upon our ability to stop before we hit something or before we are hit. An understanding of the principles involved in stopping is very important in developing safety habits on streets and highways.

Explanations of the factors that affect stopping are made in terms of energy. Thus this unit is both a part of the safety sequence that runs throughout this Series, and also a part of the sequence in mechanics. It builds upon the third-grade unit "Making Things Move," in which the term energy is introduced in a narrow sense. The concept of energy is now broadened to include the understanding that a moving body has energy and that the energy depends upon the speed of the moving body.

Many experiments are used to develop these understandings, and some of the experiments involve real situations that arise in the everyday lives of the pupils. The children thus learn at first hand through several senses, and they can make immediate applications of what they learn.

As with other units based upon pupil activities, there are many opportunities for the teacher to help the pupils learn to use caution in coming to conclusions and to look for opportunities to gather more information before making any generalizations.

PREPARING FOR THE UNIT

It is better to teach this unit during a season when outdoor activities such as running and bicycling can be carried out conveniently.

The materials needed are few in number and easily acquired. A wide board about four feet long, a toy truck and a block of wood are used in the study of factors affecting energy. To give additional experiences of the same nature one may use two balls of different weights.

A long tape measure is useful for measuring the stopping distances of children, bicycles, and automobiles. It is instructive for the children to make their own tape measure by tying knots at one-foot intervals in a long piece of heavy twine, perhaps adding a bit of colour to distinguish five-foot intervals for ease in reading.

Usually, there are several children who have bicycles that may be used in determining the stopping distances of bicycles.

To enrich the safety work of this unit, investigate the possibilities for obtaining help from local safety organizations. Some communities have safety patrols, some police departments maintain safety education divisions, and various civic organizations put on safety campaigns. From such sources one may obtain charts, reading material, films, slides, and speakers.

Driver education instructors often have a car equipped with devices that show vividly the distance needed to stop a car going at various speeds. Try to enlist the aid of an instructor and his car to make the work on the stopping distances of automobiles more meaningful.

List of Materials

- Board 10 inches wide and about four feet long
- Toy truck
- Block of wood
- Stones or other weights
- String
- Two stakes
- Tape measure
- Bicycles
- Safety literature

TEACHING THE UNIT

Because the work of this unit depends so much upon an understanding of energy, it may be desirable to review the work of the third-grade unit "Making Things Move" for the benefit of pupils who do not seem to have grasped the concepts introduced at that time.

Page 65

This page permits a discussion of the dangers involved in crossing streets and highways. It may centre about the need for traffic signals and what conditions would be like were there no signals. It may deal with the causes for accidents that have occurred recently in the neighbourhood. If possible, use a nearby intersection for an example of safety precautions.

Pages 66–67

These pages describe activities showing, 1) that moving things have energy, and 2) that the energy depends both upon the speed of the object and upon its mass, for which we use the term "weight" in this case. It is not enough to perform these experiments once: they should be repeated several times with different speeds and with different loads in the truck.

Objects other than the truck may be tested. Two balls of different weights can be rolled down the slope. One ball may be a tennis ball and one may be a baseball. Friction-top cans loaded with different materials such as sawdust and sand may be rolled down the slope. The greater the variety of experiences the more surely the pupils may generalize.

Pages 68–69

The activities here show children that they cannot stop at the instant they wish if they are running with any speed. They should know to the nearest foot what their individual stopping distances are. Be sure the string is flat on the ground before starting and caution the children about tripping over it.

The children may try to be competitive in determining their stopping distances and many will begin to slow down before they reach the line. Explain to them carefully why they should not be interested in doing better than someone else, but rather in knowing exactly the distance they need to stop. Encourage the pupils to discuss stopping distances thusly—the more energy we have, the greater distance we need to stop.

Page 70

After the stopping distances of several bicycles moving at different speeds have been determined, ask the children to discuss situations in which this knowledge is valuable. They may suggest such situations as entering a highway from a side road or a driveway, riding a bicycle beside a row of parked cars, crossing a sidewalk, coming to an intersection that has a traffic signal.

Page 71

Try to make the work of this page as vivid as possible. Take the children to a street or highway and measure off the stopping distances given, beginning at a crossing or intersection. Be sure the pupils understand that no matter how good or how poor the driver of a car may be, no matter whether the driver is in the right or in the wrong, a car cannot be made to stop immediately. Children must be on the alert every time they cross streets.

Some driver-education cars are equipped with signals that make marks on the pavement when a driver puts his foot on the brake. Ask a safety expert to demonstrate one of these cars so that the children can see how far a car actually goes before it can be brought to a complete stop.

Pages 72–73

These two pages portray a scene first through a driver's eyes and then through a child's eyes. The lesson should be clear to everyone.

Ask the pupils to use the same technique for other situations. They may consider what the driver sees when he is about to pass a bicycle rider and what the bicycle rider sees. They may consider what people see when a bus has stopped to let off passengers. Use situations that apply closely to the experiences of the pupils.

Pages 74–75

After discussing the dangerous situations on these pages, turn the attention of the children to the neighbourhood of the school. Take a walk through the neighbourhood, listing the danger spots. Make a map and locate these spots on the map. Then let the children formulate rules for their own safety about the school neighbourhood.

Pages 76–77

After these pages have been studied, consider places where the children must cross streets near the school. Visit these places and make up a set of rules for the children to obey as they cross. Consider other crossings such as those in the middle of the business section.

Safety experts are often willing to speak to the children about procedures in crossing streets. Sometimes police will set up a demonstration situation in which the pupils may practise.

Pages 78–79

There are people who feel that a negative approach to safety education is wrong, but it does seem that children should be made as conscious of mistakes as of correct things. These pages portray a few of the careless things people do every day in the busy section of a city. After the pupils have identified these things and discussed the dangers in each, ask them to think of other foolish things people may do.

Once again, help in this area may be possible from the police. Police see people do so many things that cause accidents that they are usually happy to make people conscious of these mistakes.

Page 80

The pupils should know the rules for bicycle safety. There may be local safety organizations that will help the children study this subject. Sometimes physical education teachers have been trained in safety education. Police usually are. The teacher should make use of such resources when available.

Summary Questions

1. The more rapidly an object moves, the greater is its energy.
2. A car moving 40 miles per hour has more energy than a car going 20 miles an hour.
3. Cars usually go faster in the middle of a block and therefore they need a longer stopping distance. Also, since drivers do not expect people to cross in the middle of a block, they are not ready for them.
4. A person should wait for the green light, look both ways and then start across. Then (on a two-way street) he should look left until he is halfway across and then he should be on the alert for cars coming from the right.
5. If there is no traffic light and no policeman, look all ways for cars. Be especially careful about cars coming from your left and from behind while you are crossing the first half of the street and for cars coming from your right while you are crossing the last half.
6. Bicycle riders should obey all traffic signals, they should not ride on sidewalks where this is illegal, and they should signal their intentions when they turn or stop.
7. Most accidents are caused by carelessness.

Follow-up

Material as important as this should be reviewed often. When planning trips the pupils should determine their routes and the safety measures that they will use. The pupils should be encouraged to report careful and careless things they have seen people do while crossing streets and highways. Pictures in magazines, news accounts and recent safety literature should be displayed on the bulletin board.

The relationship of alcohol to safe driving may be considered in terms of this unit. Two pertinent items are the effects of alcohol on judgment and on reaction time. Intoxicated drivers cannot estimate normally such things as distance, speed, and position of objects. Their vision is impaired: focusing becomes difficult and peripheral vision is reduced. Their ability to act quickly is lessened—even a small amount of alcohol increases the time needed to start muscles moving in order to steer or apply brakes.

Pupils should be told these facts and then given opportunities to discuss and apply them to problems of safety on the highway, not only in terms of the drivers themselves but in terms of the many other people who can be injured. Data on accidents caused by drunken driving can be obtained from insurance companies, safety bureaus, and police.

POSSIBLE LEARNINGS

Moving things have energy.
The energy of moving things depends upon their speed.
Moving objects need space in which to stop.
The greater the energy of a moving body the greater the distance that is needed for it to stop.
A knowledge of stopping distances helps us be safe.
Accidents are usually the result of carelessness.

BIBLIOGRAPHY

Books

Safety Can Be Fun. Munro Leaf. Longmans, Green: Toronto, 1938. 49 pages.

Accidents and their prevention. Humorous drawings.

Films

Alcohol and Tobacco. Coronet.

This film on tobacco and alcohol can be used at this time as part of a programme of education in the dangers of these substances.

H-32 Patty Learns to Stop, Look and Listen. Ontario Department of Education.

Patty, a farm girl, visits the city. While playing on the road, she is hit by a car, given first aid, and taken to hospital in an ambulance.

Safety on the Street. Encyclopaedia Britannica Films.

Information about street safety presented in story form.

Safety on the Way to School. Coronet.

Safe practices on our streets.

Birds in Winter

PURPOSE OF THE UNIT

In previous units the attention of pupils has been drawn to birds, but this is the first time that there has been any emphasis upon identification. In some ways, the study of birds is simpler in winter. In most sections of the country there are fewer species of birds in this season. The birds are more easily seen in leafless trees and against snowy fields. And there is always interest in the means by which these small creatures survive through harsh weather.

This unit calls attention to some of our winter residents and to their adaptations. The adaptation known as migration is referred to, but it will be treated in greater detail after pupils have become more conscious of the periodic absence and return of certain species and after the pupils have a better background in geography.

Besides fitting into the biological sequence, the unit is another one of the units designed to increase an interest in the outdoors. There are many healthful and relaxing outdoor hobbies of which bird study is one. Perhaps from this and similar units some pupils will discover avocational interest that will be very satisfying to them in later life.

Desirable attitudes may result from an increased interest in birds. Conservation of wild life depends upon the development of intelligent attitudes toward living things. A person who has a sympathetic understanding of the problems of wild creatures does not kill viciously or cause needless suffering. If he finds killing necessary as a means of control, he does so as humanely as possible. He is not swept into action by the emotional approach so often used by pressure groups. A properly educated citizenry will quickly achieve a satisfactory balance with the living things about it.

PREPARING FOR THE UNIT

Every school should have a feeding station if it is possible to set up and maintain one. There is an almost unlimited variety of types to choose from—some simple, some complicated, all useful. The children can easily make a feeding station that will fit local conditions.

It is better to set up the feeder after the Christmas holidays unless someone is willing to give it daily attention through the long vacation. Feeders should be stocked daily lest the birds undergo unintended hardship, as they constantly revisit the empty feeder instead of searching for natural foods, unable to break the habits they have formed over several days or weeks. It is better to have no feeder at all than to care for one haphazardly.

The only essential materials called for by this unit are some chicken feathers and some hand lenses with which to examine the feathers. A low-power microscope is valuable for examining feather structure.

Additional materials are desirable for enriching the unit: books with coloured pictures of birds, coloured pictures for the bulletin board, coloured slides and films, and mounted birds.

Over a period of years some valuable materials will become available and can be added to the teaching collection. A piece of bark that shows the work of a sapsucker, a rotten branch in which a woodpecker has drilled for an insect, twigs with insect eggs on them, and bark with cocoons in the crevices—these are things that help to give the work of the unit more realism.

List of Materials

Materials for feeding stations
Suet
Bread crumbs
Seeds
Feathers of several types
Hand lenses

TEACHING THE UNIT

There are innumerable approaches to the work of this unit. It can begin with observations of birds outside the window of the school, with a trip to a place where winter birds congregate, such as a barnyard, or a feed store, or a garbage dump, or with construction of a feeding station. Local resources and events should determine the approach.

The study of the text need not be followed in its present order. If crows are the first winter birds seen, they may be studied first. If grouse are absent from the region, the section dealing with them may receive only passing attention. If meadow larks are conspicuous winter residents, they may be studied although not mentioned here.

Page 81

This is a discussion page designed to set the stage for a study of the food of winter birds and to initiate the construction of feeding stations.

What do the birds in the picture seem to be doing? Who has seen some birds like them? Where were they? What were they doing? Has anyone fed these birds crumbs of bread? How tame were the birds? How close could you get to them?

Let the children relate as many individual experiences with birds in recent weeks as they wish. Encourage them throughout the remainder of the year to tell of their observations. One of the best measures of teaching success is the extent of out-of-school applications the pupils make of their school work.

Who knows what kind of bird is pictured on this first page? If no one in the class knows, explain that they are house sparrows (sometimes called English sparrows) or ask some of the pupils to look in a book of bird pictures for the name. Some pupils may notice the difference in colouring. Explain that the birds with the dark bibs are the male birds, and the others are female birds.

Lead the discussion into the problems birds face in winter: the cold, the storms, the frequent lack of water, the scarcity of food. Try to help the pupils understand about the birds' lack of reasoning ability. Birds, unlike people, cannot think out ways to make life in winter more comfortable: instead they must live with the existing conditions.

Page 82

Several birds are shown here feeding upon some natural winter foods. It is not necessary that the pupils identify these birds, but some may be able to. A downy woodpecker and a nuthatch are feeding on the same tree. A chickadee is looking for insects on a barberry bush in the foreground. Tree sparrows are feeding on weed seeds, and a pheasant is feeding on burdocks. The crows are flying, possibly to a place where foods are available.

It may be possible to take short trips to find available bird foods and possibly to see birds feeding. Birds are apt to be most active early in the morning, and trips taken as soon as school starts may be the most satisfactory.

Collections of bird foods may be started. Weed seeds and fruits may be put in glass vials or cellophane envelopes. Pieces of bark and twigs with insect eggs or cocoons may be fastened to the bulletin board with thread and thumb tacks.

For more information about the summer and winter foods of birds, see the BIBLIOGRAPHY on pages 63–64.

Page 83

This page describes one of the many types of feeders that pupils can make. Local conditions may make other types of feeders more desirable. The pupils should discuss the problem and make the decisions. Then they should assemble the materials and proceed with the construction. First bore holes in the round stick. Then nail the square board on the bottom and tack on the sides. Finally, attach wire to the nails at the top for hanging the feeder.

Some foods suitable for the feeders are:

- suet (beef fat)
- peanuts
- peanut butter
- bird seed
- mixed grains
- sunflower seeds
- dried corn
- dried bread crumbs
- broken dog biscuits

Pieces of suet must be fastened down so that the larger birds do not carry away entire pieces. In the feeder shown, the suet is pounded into the holes. Suet may also be put in bags of coarse mesh or covered with a piece of coarse wire screening.

Some pupils may wish to have feeders at home. Try to make the pupils understand the necessity for daily attendance. Encourage them to work with their parents on the project.

Pages 84–85

These pages need little elaboration. Direct the pupils to read the pages and then ask them questions about the content. Encourage the pupils to tell about their own observations of these and similar birds.

If there are rough-barked trees in the neighbourhood, take the class to look for insect eggs and cocoons in the crevices. If there are low evergreens, they may look for eggs and cocoons among the needles. Tent caterpillar eggs may be found on small cherry trees.

Sometimes woodpecker work can be seen on trees near the school. Take a trip to see these indications of feeding activity.

Pages 86–87

The crow is probably condemned too harshly by farmers and given too much credit for intelligence by the sentimental. You can help your pupils to maintain a balanced attitude by discussing the bird without bias. The crow is known to feed upon newly-planted corn in early spring and upon insects, many of them harmful, throughout the growing season. Always try to balance the good and the bad so that pupils develop the habit of looking at both sides of controversial issues.

These pages show a day in the life of some crows, and touch upon the way they often meet the problems of food and shelter. If suitable books are available, ask pupils to find out more about the winter habits of crows. Also encourage the pupils to observe crows and report on their activities. (Notice the wing marks on page 86 showing where the crow took off.)

Pages 88-89

These pages mention some common seed-eating birds. Do not let the pupils generalize too broadly about any relation between bill shape and food types. The thick, heavy bills of sparrows and finches are useful to these birds for cracking seeds, but they do not prevent them from eating insects and soft fruits. Indeed, at some seasons, they feed more extensively on soft foods than on seeds.

Plan a short trip to a nearby field or vacant lot to collect seeds that remain above the snow. Perhaps birds will be seen feeding on these seeds; perhaps tracks will be seen in the snow. When birds are identified, ask certain pupils to find out more about the birds by reference to suitable books.

Pages 90–91

These pages should be treated much like the pages dealing with the crow. The children may tell stories based on these pages. Some pupils may enjoy finding out more about grouse by reading and observing.

Pages 92–93

The study of feathers opens a new approach to the problem of how birds survive the winter months. As shown in the first figure, the feathers overlap like shingles, helping to shed water that might otherwise chill the bird. The feathers are made more waterproof by a coating of oil. Part if not all of this oil comes from a gland located on the rump of the bird. Pupils who have hens or canaries at home may have seen these birds digging at their backs and then preening their feathers; this act forces oil from the gland to the bill after which the bird spreads the oil over the feathers.

Each pupil should be given a flight feather of some large bird such as a hen or a turkey. Ask the pupils to find the quill. Then have them note that the feather on either side of the quill can be pulled apart into small fibres. A hand lens will help the pupils see that each fibre is edged with tiny projections. A low-power microscope will show that these are hooks. Show the pupils how to hook these little projections back together again by stroking the feather between the thumb and forefinger.

Few pupils realize the insulation qualities of feathers. In some countries, down-filled comforters have long been used for bedding. Campers know that the best sleeping-bags are filled with the down of geese and ducks. There are now on the market jackets filled with bird down.

When birds fluff out their feathers they are increasing the insulation quality of their feathers by adding to the amount of air trapped under them. The feathers which trap the most air, and which are therefore best adapted for insulation, are the fluffy ones. Almost all feathers show some fluff at the base, but there are some feathers that are completely fluffy and these are the ones called "down." Ask the pupils to study down feathers and compare them with the other feathers.

It is possible to expand this section much further. The pupils may make a full-size drawing of a hen and paste on the drawing in the proper location feathers that illustrate the various adaptations for flight, warmth, and rain-shedding. Dead birds that are brought in can be turned to good advantage the same way.

Pages 94–95–96

Most pupils will have noticed the absence of several familiar summer birds. They will have heard that these birds leave for warmer regions in winter. Three such migratory birds are mentioned here.

The class should study other species that they recognize as absent from their locality for the winter. They may find information on the summer and winter ranges of native birds in most bird books. At the same time, pupils may investigate some of the species that come to their locality during the winter from regions farther north.

There is a common tendency to consider that birds migrate to find more food or to escape from cold weather. We have no evidence that birds migrate with a purpose in mind. Best authorities today believe that birds merely obey an inborn urge when they migrate.

Summary Questions

1. The answers to this question will depend largely upon local conditions. However, such fruits as strawberries and raspberries and such insects as grasshoppers and leaf-eating caterpillars will probably be mentioned.
2. These birds are generally meat-eating birds and find insect eggs, cocoons, and dormant adults on twigs and in crevices of bark. The woodpeckers also find beetle grubs in rotting wood. These birds eat suet if people put it out for them.
3. Crows eat seeds such as corn, as well as garbage and dead animals.
4. A sparrow has a broad, heavy bill well adapted for seed cracking.
5. Pupils can have a feeding station or they can merely scatter crumbs on the snow. Adults can encourage birds in winter by planting shrubs, particularly shrubs that hold fruits well into the winter.

6. The answer to this question depends upon the locality. In most northerly regions fewer birds are seen in winter because more birds have migrated out of the area than have migrated into it. However, in certain other localities enormous numbers of birds winter, far more than migrated from the region.

Follow-up

Children should be encouraged to continue independent observations through the remainder of the winter and into the spring. The feeding station, too, should be maintained until natural foods become abundant in the spring. As new species are seen and identified, encourage the pupils to read about them and report their findings.

POSSIBLE LEARNINGS

Some birds are adapted for winter conditions.
Foods for birds are often scarcer in winter than in summer.
Some birds find insects in winter.
Some birds find seeds and fruits for food in winter.
Feathers help to keep birds dry and warm.
Some birds fly to warmer regions in winter.

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Books

Birds in Their Homes. Addison Webb. Blue Ribbon Books: Toronto, 1947. 66 pages.

Has fine illustrations of eggs and nests.

Cornell Rural School Leaflets. Cornell University. Thomas Allen: Toronto.

The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Everyday Birds. Gertrude Allen. Thomas Nelson: Toronto, 1943. 41 pages.

A simple, enjoyable book. Contains good material on chickadees and crows.

Handbook of Nature Study. Anna Botsford Comstock. Thomas Allen: Toronto, 1947 ed.

Valuable for general reference and as a teaching guide. An up-to-date natural history library in one volume.

Starlings. Wilfrid Bronson. W. J. Gage: Toronto, 1948. 78 pages.
A story-book worth knowing.

Winter Flight. Alice Gall and Crew Fleming. Oxford: Toronto, 1949.
The story of a young crow and other birds—their homes, enemies, and migration.

Films

Birds in Winter. Coronet.
Feeding habits and adaptations of ten birds commonly seen in winter.

Common Birds of Canada. National Film Board.

Canada Goose. National Film Board.

Recordings

American Bird Songs—Vol. 2. Comstock. Thomas Allen: Toronto.

Canadian Bird Songs Album. Cornell University. Thomas Allen: Toronto.

Sounds of Nature—Vol. 1. Federation of Ontario Naturalists.

Water in Plants

PURPOSE OF THE UNIT

This unit contributes richly to the development of an awareness of things about us. It deals with commonplace materials and commonplace phenomena. The knowledge gained through this study is of great importance in caring for plants.

The unit is a part of the sequence on plants and plant physiology, building on such earlier units as "Planting Seeds," "Travelling Seeds," "Buds," and "Growing Plants Indoors." It leads towards other plant units such as "Flowers and Their Work" and "Plants and Light."

An understanding of the water relations in plants is fundamental to an appreciation of the "problems" of plants. This unit has been treated in such a way as to bring out the importance of the physical environment. It develops further some of the concepts concerning humidity as introduced in the unit "Growing Plants Indoors," and it introduces new concepts relating to the importance of soil, and to the varying tolerance of plants for available moisture.

Like so many other units in this Series, this unit is based almost completely on activities that involve manipulation and learning at first hand. This approach serves to maintain a high degree of enthusiasm on the part of pupils.

Several controlled experiments are suggested in this unit. It is important that pupils realize and recognize the controls and their purpose. They should know why there is a second plant in the experiment on page 98, and why the second jar is used in the experiment on page 108. Throughout this unit, and throughout all other units, the teacher should continually caution the children against drawing conclusions that are not justified by the facts observed.

PREPARING FOR THE UNIT

This unit is suggested for the early spring season when sap is beginning to flow. In regions where there are sugar maple trees it may well coincide with the maple sugar season. The unit, "Things That Dissolve," should precede this unit because concepts involving solutions are used in the study of liquids in plants.

Elaborate equipment is unnecessary. Collect beforehand some house plants such as coleus plants, some corn and bean seeds, some flower pots, two one-gallon glass jars, and some drinking glasses. As the unit progresses, some blanched celery, some white carnations, and some freshly-cut willow twigs are needed.

The corn and bean seeds should be planted about two weeks before they are called for by the suggestions on page 104. It is well to start a number of these plants in case some do not survive.

In sugar maple country, the teacher may make arrangements for a trip to see maple sap being processed. If there is a nearby maple tree, arrangements might be made to tap it and to boil down the sap to make syrup. For this, one needs a spile, either purchased or whittled from wood, a brace and bit to bore a hole, a collecting can, and a hotplate or other source of heat.

To enrich the early part of the unit, a number of desert and aquatic plants may be grown in the classroom. These may be acquired in the fall. If trips to desert gardens and water-lily gardens are possible, these may be taken in the fall or spring and then related to the unit.

List of Materials

- Coleus or other house plants
- Aquarium plants
- Cactus and other desert plants
- Blanched celery stalks
- Sharp knife or apple corer
- Red ink
- Bean seeds
- Corn seeds
- Hand lenses
- Sand
- Small glass jars
- Willow twigs
- Gallon glass jars
- Cardboard
- Carrots
- Sugar
- Flower pots

TEACHING THE UNIT

This unit is flexible and its sections may be taken up in any order. Often there is a local situation that serves as a good introduction to the unit. Then the most closely-related section of this unit should be considered first. It is recommended that the section on the way water gets into roots, pages 110–111, be delayed as long as possible because the concepts involved are the most difficult to grasp.

Page 97

This title page represents an experience common to many children. **What is the boy doing? Why is he watering the plants? Do you need to water garden plants all the time? When do you need to water them? What happens to plants that have too little water?**

The children will probably answer the last question with the statement that the plants die. This is a correct answer if the lack of water continues, but first many plants will wilt. The wilting reaction is dealt with in the experiment on page 98.

Page 98

To demonstrate the relationship between water and plants we may carry out the controlled experiment described here. We need at least two house plants that will wilt and then recover when watered. If possible use four or six. Coleus plants are suggested, but others may be used. Some plants are not satisfactory; geraniums, for instance, lose their leaves when they are allowed to become dry—their leaves do not wilt.

Label the plant pots with chalk to distinguish them and put little signs beside the pots telling when the plants were watered last.

After one group of plants has wilted, they may be watered and the other group may be deprived of water. This gives a better check.

Page 99

Not many children will have had first-hand experiences with irrigation, so we must use pictures and films to establish understanding. To help the children to visualize the mechanics of irrigation, a model may be set up in a sand table.

Pages 100–101

These pages show plants that have the extremes of tolerance for available water. Representatives of these two extreme groups can be kept in the classroom.

Submerged but unrooted forms do well in a standard aquarium; some of these can be found in ponds and others may be purchased in pet stores. Rooted forms should be planted in small glass dishes of earth, the pots being buried in sand at the bottom of the aquarium. Fish may or may not be put in the aquarium.

A number of cacti and associated forms are sold as house plants. These thrive in the dry air of a classroom. One may plant them in separate pots or one may make with them a desert garden in a large aquarium. Wild cacti bloom during the short rainy season. During the remainder of the year they are less active, but they do not die because they store water in their thick leaves.

In some communities there are people who make a hobby of water-lily gardens and cactus gardens. There are often bogs, swamps, and ponds near the school. Trips to any of these may be taken when the season is best suited for trips. The observations may then be related directly to this unit.

Pages 102–103

These pages suggest an activity introducing a basic concept—that water rises upwards in stems. Blanched celery is recommended because the lack of green colouring permits one to see readily the path of the red ink.

To insure maximum participation, each pupil or each pair of pupils should have a celery stalk. The pupils may put their stalks in glass jars; one jar will hold two or three stalks.

Several hours are needed for the ink to rise into the leaves. The stalks may be left in the red ink overnight, or the activity may be started in early morning. In the latter case the children can note the upward progress of the red ink.

When red appears in all the leaves, the pupils may use hand lenses to study the delicate tracery of red. The stalks should then be cut across as shown, and the pieces broken lengthwise. The red "strings" can be pulled loose for study. The same "strings" may also be pulled from an uncoloured stalk.

Page 104

We now show that red ink enters the roots of plants and moves upwards. The seeds should have been germinated two or three weeks before they are needed. Corn, beans, and peas contain sufficient stored food to develop the first leaves without light. If the seedlings are kept in darkness they will be yellowish rather than green, and the network of red will show better.

At the bottom of the page a related activity involving white carnations is suggested. Other white flowers may also be tested.

Page 105

The activity suggested on this page broadens the concept already introduced by extending it to woody plants. Willow twigs are suggested because they are common and because they react speedily. New growth of woody plants, such as apple and ash, should also be tried. Different children may try different species.

A sharp knife is needed to cut apart the twigs and to split them lengthwise. The teacher should do this for the pupils.

Hand lenses help the pupils study the location of the region through which the red ink rises.

Several applications will suggest themselves. **How can hollow trees continue to live? Why do people often cut off a ring of bark round a tree they wish to kill?** (This is known as "girdling" a tree.) **Why do rabbits and mice damage orchards so much when they eat the bark?** An understanding of the path of water just under the bark of a tree helps to answer these questions.

Pages 106–107

We have already mentioned sugar in sap in the unit "Things That Dissolve." We now strengthen the concept. It is a concept that will be further expanded and developed in the fifth-grade unit "Sugar and Starch" and in the sixth-grade unit "Plants and Light."

In the diagram of the sugar maple tree, the children should notice that the spile goes only a little way into the tree. The work of the previous page should help them understand why the spile need not go deeper into the tree.

If there are sugar maple trees near the school, and if permission can be gained to tap these, make some maple syrup. The process is not difficult. A hole the size of the spile is bored into the tree and the spile is pounded into it. A clean metal can serves as a sap bucket; you will need to punch a hole near the rim of the can to slip over the hook on the spile.

Gather the sap once or twice a day. After several quarts have been collected, boil the sap in an open kettle. As the syrup thickens be careful that it does not burn on the bottom of the kettle. It is possible, through slow, careful heating to make sugar from the thick syrup, but there is greater danger of burning. The final stages may be carried out in a double boiler.

If possible, take the entire class to see maple syrup being made commercially. It is an unforgettable experience.

On page 107 two other plants that have sap rich in sugar are illustrated. In regions where these plants are grown, they may be studied in greater detail.

Pages 108–109

Another controlled experiment is described here. The problem which the experiment is designed to solve is "What happens to the water that goes up the stems of plants?" Cardboard is placed over each pot so that water from the soil doesn't evaporate into the air of the glass jar. See if the children can reason out the purpose of the cardboard for themselves. Also, why is the second jar used?

One observation is not sufficient. They should try the experiment several times, both with the same plant and with others. They may also try variations of the experiment. For instance, they may tie cellophane bags round leafy twigs, or they may slip a plastic food bag over an entire plant. In proper season, some of these experiments may be done on plants out-of-doors.

We do not attempt to answer the question, "What makes the water rise in plant stems?" There are several explanations that have been suggested but no single one has been accepted completely. The tendency is to believe that there are several factors that cause the rise of liquids in plants. One such factor is touched upon in the next activity.

Pages 110–111

We now consider the mechanics of the entrance of water into plant roots. A controlled experiment is used to develop the understanding.

The holes in the carrots may be made with an apple corer (as shown) but they may also be made with a sharp knife. A large cork borer, such as chemistry teachers use, will do the job neatly and quickly.

It is possible to vary the experiment more than is shown here. Two additional carrots, one containing fresh water and the other sugar water, can be put in jars of sugar water. In the first of these cases, water in the carrot will be drawn out into the jar of sugar water, thus helping the children understand that it is the tendency of liquids to go towards the greater concentration of dissolved sugar.

We do not try to answer the question as to why the water moves through plant membranes towards sugar solutions. This is one of the basic principles of science which, like the magnetic attraction for iron, and like life itself, has no certain explanation. Present-day explanations of the movement of liquids in plants involve the molecular theory, for which children of this level have insufficient background to insure understanding.

The movement of soil chemicals into the plant represents an important application of the principle being studied on these pages. In rural and suburban places where farming and gardening develop a consciousness of fertilizers, this area may be expanded. Labels of fertilizer bags may be brought in and displayed. Samples of fertilizers may be exhibited. Experiments showing the effects of fertilizers on plants may be attempted.

Page 112

A number of animals, particularly insects, feed on the sap of plants. The life history of the sapsucker may be studied in regions where it is common. The class may be taken to trees that have been tapped by sapsuckers. Sometimes a scarred tree specimen may be added to the school collection.

Among the insects, the spittle bug—which is shown here—is well known. The bubbles it blows conceal it from its enemies. Aphids, often called plant lice, are also seen everywhere. Aphids become great pests. House plants are often infested by aphids, and the children should become familiar with them. Many garden plants are seriously weakened by aphids, and children should know how aphids are combated. There are a number of sprays and dusts that are used; these may be exhibited in the classroom.

Summary Questions

1. Sugar is common in the sap of most plants. We have also seen that small amounts of soil chemicals may be dissolved in sap.

2. Sap rises in the outer part of the wood of a tree. This part is called the "sapwood."

3. Most of the water in a plant has entered through the roots of the plant. This is referring, of course, to typical green, land-living forms. Aquatic plants may absorb water through any part of the plant.

4. The children may name any of the aquatic and desert forms with which they are acquainted.

5. In a celery stalk, the sap rises through certain regions which the children may call "strings," and which the scientists call "vascular bundles."

6. Fertilizer dissolves in water in the soil which may enter the roots of plants.

Follow-up

In all experiences with plants there are opportunities to refer to the sap in the plants. The children will often notice the sap when they pick flowers. During gardening season they will see fertilizer being used. Someone may girdle a nearby tree to kill it. Mice or rabbits may injure apple trees. These all present opportunities to apply the learnings of this unit.

POSSIBLE LEARNINGS

Plants need water.
Water enters the roots of plants.
Water rises up special regions in plant stems.
Some of the water that enters the leaves of plants evaporates into the air.
Water in plants often has sugar dissolved in it.
Soil chemicals dissolve in soil water and enter plant roots.
A number of animals make use of the sugar in sap.

BIBLIOGRAPHY

Books

Audubon Nature Bulletins. Prepared and published by the National Audubon Society, New York. 4 pages each.

Several of the bulletins contain background information to supplement this unit. List sent by the Society on request.

Cornell Rural School Leaflets. Cornell University. Thomas Allen: Toronto.

The leaflets contain background material and information on almost every science topic. Consult the list of titles.

Play with Plants. Millicent Selsam. George J. McLeod: Toronto, 1949. 62 pages.

Shows how plants develop from seeds and how they respond to water and light.

Up Above and Down Below. Irm Webber. S. J. Reginald Saunders: Toronto, 1943. 31 pages.

Easy text and simple illustrations showing parts of a plant and its functions.

Films

Garden Plants and How They Grow. Coronet.

The growth of some common plants as seen through time-lapse photography, with close-ups showing the movement of water and other functions in the plant.

Roots of Plants. Encyclopaedia Britannica Films.

Valuable for its excellent time-lapse photography showing root growth in relation to water.

Static Electricity

PURPOSE OF THE UNIT

The sequence of electricity and magnetism continues in *Exploring Science Four* with a unit on static electricity. Many commonplace happenings can be explained with some of the elementary principles taken up here. The activities encourage children to be more observant, to be curious, and to search for cause-effect relationships.

The concept of energy as applied to electricity is introduced at this time. It is treated from the standpoint of the ability of an electric charge to produce motion. This takes advantage of the concepts developed in the third-grade unit "Making Things Move." In later grades other aspects of electrical energy will be considered.

This unit stresses activities that involve manipulation, thus giving the pupils an opportunity to learn through first-hand experiences. Many of the activities help develop powers of co-ordination.

Some of the suggested experiments permit the pupils to devise their own controls. For instance, when the pupils see that a comb picks up light objects after it has been rubbed, they are encouraged to wonder if the comb would have picked up the same things before it was rubbed. They should then devise a simple control that would enable them to draw conclusions safely.

Pupils may wonder about some of the basic principles in this unit, asking "Why does a comb pick up bits of paper?" Like magnetism and many other things in science, electrical attraction and repulsion must be accepted. There are theories that charged objects have an excess or a deficiency of negatively charged electrons and that forces between charged objects are due to the attraction between electrons and protons or to the repulsion of electrons or protons for each other. However, such theories do not account for the forces themselves. The answer to questions like the above, in terms of present understandings, must be "No one knows."

PREPARING FOR THE UNIT

Static electricity experiments give the best results when the air is dry. It is recommended that this unit be taken up during midwinter when the air indoors is usually dry. In some regions, the air may be so moist at all times that good results are not possible. In such places it is better to give this unit only passing attention and use the extra time to elaborate on more suitable units.

The activities call for a number of simple items. If possible, these should be provided in quantities so that all pupils can carry out the activities. Pieces of silk cloth and wool cloth are used in most of the experiments. Brushes, such as clothes brushes and hair brushes, are occasionally needed. The children will also need pocket combs made of various materials, rubber balloons, fountain pens, thread, tin foil, and glass bottles. A ping-pong ball, a shallow pan or cake dish, and a celluloid swan complete the list of materials.

For enrichment, one may have pictures of lightning flashes for the bulletin board. Access to a large rug on which the children can scuff their feet to develop charges will be of value. Another helpful device is a small radio of the AM type so that the children can hear the effects of a spark on radio reception.

In the region around the school there may be buildings with lightning rods. There may also be trees that have been struck by lightning. These present possibilities for interesting field trips.

List of Materials

- Pieces of wool cloth
- Pieces of silk cloth
- Combs
- Celluloid bathtub toy
- Pan of water
- Thread
- Brushes
- Sheets of paper
- Rubber balloons
- Tin foil
- Glass bottles
- Small AM radio if possible
- Fountain pens
- Ping-pong ball

TEACHING THE UNIT

This unit has been organized so that the simplest concepts are developed first. Many of the more complex ideas developed later are built upon those presented first. It is well to take up the material in the order given.

The terms "positive" and "negative" are not used in this unit, but a teacher may introduce them if she wishes. The charges produced on rubber by rubbing it with wool are negative charges; the charges produced on glass by rubbing it with silk are positive charges. The important thing at this time is to develop the concepts first; vocabulary can be developed later.

Page 113

This page illustrates an experience common to many children. If possible, take the children to a large rug and let them scuff their feet on it to build up charges. One can then be sure that all the children have the experience.

Ask the children to relate experiences they have had with sparks of this kind. Besides those produced by walking over rugs, they may have acquired charges by riding in automobiles or by sliding about on polished chairs while wearing wool clothing.

Page 114

After the children have experimented with pocket combs as shown, encourage them to try other things such as fountain pens, rulers, pipe stems, and other objects made of various plastics.

There is a tendency to consider that static electricity is much like magnetism because both attraction and repulsion are exhibited in experiments with each. However, the two are not closely related, if at all. Magnetic attraction is confined chiefly to objects made of iron. Static electricity attraction applies to many substances.

Pages 115–116–117

The activities described here suggest many other similar activities. The more of these activities the children can improvise and carry out, the nearer we come to meeting the aims of a good science programme. In all the experiments, try to make the children conscious of the need for controls by asking, "Would it happen this way if you didn't rub the balloon?" and similar questions.

After the term "energy" has been applied to static electricity charges on page 117, return to the earlier experiments and discuss them in terms of energy. Encourage the children to explain the movement of bodies in the experiments as due to electrical energy.

Page 118

If there is a room in the school that can be darkened, use it for the experiments on this page. Then encourage the children to try the experiments at home.

Pages 119–120–121

To enrich this section, post pictures of lightning flashes and take trips to see damage done by lightning if there is such damage in the neighbourhood. If there are buildings protected by lightning rods, visit these also.

Give attention to safety precautions during thunderstorms, but try not to frighten the children. Actually, few people are injured by lightning and only a few precautions are needed.

Pages 122–123

The experiments on this page are based upon the principle that two bodies with similar charges repel each other. Strips of paper charged by the same procedures obviously have the same charges. The same is true of rubber balloons.

In the experiment with the ball of tin foil, the situation is more complex. At first the charged comb attracts the uncharged ball. When the two touch, some of the charge on the comb jumps to the ball. Then the ball has a charge of the same kind as the comb has and the two repel each other.

Pages 124–125

The charge produced on glass with silk is usually called a "positive" charge. As the experiments show, a charged bottle will pick up bits of paper just as a charged rubber balloon will. But whereas two rubber balloons repel each other, a charged bottle will attract a charged balloon. Thus we know that the charges on the bottle and the balloon are not the same.

Pages 126–127

These pages continue experimentation with the two kinds of charges. The method used to determine the charge of a body is described in detail. Give the children an opportunity to test many different objects for the charges that have been produced on them.

Page 128

Children who have listened to standard broadcasts on their radios have undoubtedly noticed the great amount of static during thunderstorms. Radios known as FM radios are not bothered by this kind of static. Television is affected only slightly.

If possible, bring in a small radio and tune it to some distant station so that the volume control is turned up high. Then produce electric sparks by some of the methods described in this unit. The children will hear a snapping noise on the radio each time there is a spark.

Summary Questions

1. There are two kinds of electric charges known to scientists.
2. Lightning is an electric spark.
3. It is dangerous to be under a tall tree, alone in a field, or out in a small boat in a thunderstorm.
4. Objects with unlike charges attract each other.
5. Lightning rods are metal rods connected to the ground. Electricity flows down the rods to the ground, instead of doing damage to a building.
6. Electrically-charged objects can make other objects move, showing that they possess energy.

Follow-up

During periods when the air is dry, some of the materials used in the experiments with static electricity can be put out for the pupils to use again. Thus they review their learnings and have an opportunity to broaden their concepts.

Should a thunderstorm occur, time may be taken to review what has been learned about lightning. The children may be interested in investigating this subject further by reading in encyclopedias and other science books. See the BIBLIOGRAPHY below.

POSSIBLE LEARNINGS

Many objects can be given electrical charges by rubbing them.
Charged objects have electrical energy.
Charged objects attract uncharged objects.
Charged objects repel other objects that have the same charge.
Charged objects attract other objects that have unlike charges.
A spark results when an electric charge jumps through the air.
Lightning is an electric spark. Thunder results when the spark goes through the air.

BIBLIOGRAPHY

Books

Lightning and Thunder. Herbert Zim. George J. McLeod: Toronto, 1952. 58 pages.

Answers many questions about thunderstorms and lightning.

Films

Thunder and Lightning. Young America Films.

Explains thunder and lightning in simple terms.

Balancing Forces

PURPOSE OF THE UNIT

In each book of this Series, experiences in different areas of mechanics are suggested. There were experiences with pulleys in the first-grade unit "Watching the Flag." There were experiences with gravitational forces, wheels, and friction in the second-grade units "The Pull of the Earth" and "Moving Things More Easily." There were experiences with ways of storing energy in the third-grade unit "Making Things Move." In this unit there are experiences with balancing forces, with specific applications to levers and weighing. The unit builds directly on concepts developed in the second-grade unit "The Pull of the Earth."

As with all units in mechanics, emphasis is placed upon the direct experience approach. We gain our best appreciation of forces and mechanical devices, not through seeing or reading about them, but through sensations involved in muscular effort. Nearly every page, therefore, suggests things for the pupils to do with simple equipment.

This is part of the programme of educating the children through all their senses.

The principles developed in this unit have numerous applications in our everyday lives, sometimes explaining commonplace phenomena, sometimes making it possible for people to do things in easier ways. This work is designed to awaken and to satisfy children's curiosity about the things around them.

PREPARING FOR THE UNIT

The unit may be taught at any time of the year. No extensive preparation is needed.

The activities call for a few common materials. Playground seesaws may be used for the first experiences with balancing. If the weather is such that outdoor work is undesirable, a saw horse and a plank are needed. The janitor of the school can often provide these.

A narrow, thick board known as a two-by-four is needed for the activity on balancing the body. Other pieces of wood, nails, screw eyes, and string are needed for the remaining activities. It is also helpful to have a beam-balance scale for study and a bicycle to illustrate the action of a crank. One should also have as many illustrations of common levers as possible—a nutcracker, pliers, shears, a can opener, a nail-pulling hammer, a pinch bar, and the like. Devices to illustrate cranks are also desirable—rotary can openers, a food chopper, a pencil sharpener, and so on.

List of Materials

Seesaw
Narrow plank
Wood blocks or bricks
Pieces of pine lumber
Screw eyes
Nails
String
Thin board about three feet long
Strong board about six feet long
Examples of cranks, such as pencil sharpener, rotary can opener
Examples of levers, such as a nutcracker, pliers, shears
Yardstick or similar stick
Beam-balance scales as shown on page 143 if possible
Bicycle

TEACHING THE UNIT

The unit has been organized so that the simplest concepts come first, forming a basis for later experiences. It is recommended that the material be presented in the order in which it is given.

The only word that might have new connotations is the word "lever." This word is often applied narrowly to some fixed device such as a brake lever or a gear-shift lever that actuates some piece of machinery. It is used here in the broader sense. Children should have no real difficulty in expanding their concept of the word.

Page 129

This title page with its reference to the circus recalls many experiences with balancing things. Besides the ones shown, the children will think of many more—balancing on stilts, balancing a stick on the end of a finger, standing on one foot, and standing a bottle upside down.

The problems to be raised at the end of this discussion are what do we do to make things balance and why do they balance.

Pages 130–131

Experiences with a seesaw are certainly not new to the pupils but the interpretation of the experiences will be. For that reason this section should not be slighted.

Some pupils may suggest from their past experiences ways that a heavy pupil can be balanced by a light pupil. Let them show how they can do this, but do not attempt to interpret what they have done. Later, return to this section after levers have been studied.

Pages 132–133

These pages explain why things balance or fail to balance in terms of forces. After these pages have been studied, the discussion may be turned to an explanation of why some of the things on the title page balance. Other things that balance may also be discussed.

Pages 134–135

These balancing tricks are mostly "just for fun," but they may also be studied from the standpoint of forces. After the children have failed to pick up the objects in the ways shown, move the objects out away from the walls and ask the children to pick them up. The children will see that an individual shifts his position as he bends over so that part of his body is behind his feet while the rest of it is in front of his feet. In the tricks described, it is impossible for the individual to shift his body to this balanced position.

Pages 136–137

The weighing balance described here is rugged and yet fairly sensitive. Children should have little trouble making it. Find the long nail first and cut the base board to the proper width afterwards.

Although a pound of sugar is shown as a weight that may be used in the balance, it is more useful to make up a set of weights using something like sand or nails. These may be put in bags and labelled. Suggested weights are: three one-ounce weights, one quarter-pound weight, one half-pound weight, and a one-pound weight. Others may be added as desired.

Suggest this procedure for weighing out a pound of water: balance an empty container for the water, one which will hold about a pint, against any small weights. Leave these small weights on one pan of the balance and add a known one-pound weight. Then fill the container on the other pan with water until the pans balance. Since the smaller weights balance the empty container, the weight of the contents alone is one pound.

Pages 138–139

On these pages pupils learn how to balance light objects with heavy objects. It is helpful to use books of the same kind in these experiments so that the weight of each is approximately the same. The children will learn that heavy objects near the balancing point will balance light objects farther from the balancing point.

Ask the children to guess how the books on page 139 can be balanced. Then ask them to check their guesses by experimenting. Methods for balancing children of unequal weights on a seesaw may now be discussed and tested, with reference to pages 130–131.

Page 140

The experiment on this page shows how we can make practical use of the work of the preceding pages when we must raise something heavy. Give all the pupils an opportunity to try the experiment and to feel with their own muscular senses how the lever reduces the force needed to lift the heavy box. Be sure each one pushes down at several points along the bar so that he learns the effect of changing the length of the lever arm.

Leave the materials out for a few days so that the pupils can repeat the experiment as often as they wish. They will learn a great deal as they manipulate the lever in different positions.

Page 141

Here are four applications of the simple lever. With the exception of the pump handle, there should be little problem in having the devices in the classroom for study. Other devices that may be studied are: a pinch bar, a bottle opener, a screwdriver prying the lid from a friction-top can, and shears.

Page 142

The balance described on pages 136-137 is most useful for weighing out quantities of things. The balances described on this page are also useful for determining the weight of an object. Most balance scales work on this principle.

For a sliding weight on the homemade balance, use a cloth bag of sand or a can of sand. Tie it to the yardstick with a tight-fitting loop of twine. It is not necessary to use an actual yardstick; one may use any wooden bar marked off in equal units.

Page 144

As explained in the text, cranks are levers. If one understands the principles of levers, he also understands cranks. There are many applications of cranks that pupils will recognize. Besides the cranks on a bicycle, pupils will recognize the cranks on pencil sharpeners, food choppers, rotary can openers, hand drills, and egg beaters. The auger brace, used for boring holes in wood, is a crank. Wrenches, handles on faucets, some types of door latch handles, and bicycle handle bars, are also types of cranks. Try to have a number of these devices in the classroom for study.

Summary Questions

1. Things may balance when the forces acting on one side of a body equal the forces acting on the other side.

2. When the forces acting on one side of an object are greater than the forces acting on the other side, the object may become unbalanced and tip over.

3. If a heavy person is closer to the balancing point than a light person, the two may be in balance.

4. The children may describe either or both of the two weighing balances described in this unit on pages 136-137 and 142.

5. By putting a heavy object near the balancing point of a lever, we can raise the object easily if we press on the end of the lever farther from the balancing point.

6. With scales of the balance type, a person's weight is applied close

to the balancing point of the beam, and the small weight is relatively far from the balancing point.

Follow-up

Many of the experiments with levers can be repeated at different times through the year by putting the needed materials where the children can use them. After taking up new topics, children often like to come back to experiments they have done before.

An exhibit of cranks and levers may be used as follow-up. Pictures, pupil-made diagrams, and actual devices make up the exhibit.

As new applications of the principles in this unit are encountered, time should be taken to call them to the attention of the pupils.

POSSIBLE LEARNINGS

If the earth pulls equally on each side of an object, the object is in balance.

If the earth pulls unequally on opposite sides of an object, the object is out of balance.

A force acting close to the balance point of a lever can be balanced by a smaller force acting farther away from the balancing point.

We use levers to help us move heavy objects or to apply a large force.

Cranks are levers.

BIBLIOGRAPHY

Books

After Dinner Science. Kenneth M. Swezey. McGraw-Hill: Toronto, 1948. 180 pages.

Many illustrated experiments involving forces and balance.

Fun with Science. Mae Freeman and Ira Freeman. Random House: Toronto, 1943. 60 pages.

An additional source of activities.

Now Try This. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1947. 40 pages.

Simple, illustrated experiments with levers.

Science Magic. Kenneth M. Swezey. McGraw-Hill: Toronto, 1952. 182 pages.

Has several experiments that teachers can use.

How We Move

PURPOSE OF THE UNIT

One of the major aims of a modern science programme is to awaken and expand an interest in the human body. With children this is no real problem because children are intensely interested in themselves. But too often the only gratification of such interest is in morbid and pathological aspects—freaks, diseases, and accidents. Small wonder that so many adults look upon the study of the human body with disfavour.

In the Exploring Science Series, however, we are stressing normal, healthy conditions. A knowledge of the healthy human body is essential to the intelligent development of sound health habits as opposed to worthless fads and downright neglect.

The study of the human body serves another purpose. Physically, we differ from many animals only in degree; the study of the human body is a type study which lends itself to ready comparisons with many common animals. Thus we are studying the physiology of animals in general.

The unit builds directly upon such earlier units in the Series as "We Are Growing," Book One, "When We Run and Play," Book Two, and "Teeth" and "Hearing Sounds" in Book Three. It serves as a background for later studies of the human body.

The concept of energy, developed carefully in units on mechanics in earlier grades, is here broadened to include the form of energy stored in foods and utilized in our bodies. The food-carrying function of the blood is introduced but not elaborated upon at this time.

PREPARING FOR THE UNIT

The most important materials, muscles and bones, come into the classroom with the pupils each day. The teacher need not be concerned with trying to locate them.

There are, however, other materials which serve to enrich the unit. Best of all is an articulated skeleton which may sometimes be borrowed from a high school science department. Without an actual skeleton, the teacher may substitute manikins or charts of human skeletons.

In the study of joints, touched upon briefly in this unit, bones of common animals are helpful. The thigh bone and lower leg bone of a chicken show hinge action. The thigh bone and pelvic bone of a chicken show ball-and-socket action. Corresponding bones from other animals are equally useful. To remove the grease from the bones, cook them in hot, soapy water. Such bones may be used year after year.

A piece of meat may be displayed to show what muscles are like. Fresh, lean beef shows how the muscles look naturally. The same meat boiled shows the individual muscle fibres.

The teacher may arrange for a trip to a meat shop to see a beef carcass and cuts of meat.

List of Materials

Scraps of lumber
Nails and string
Tacks
Chicken joints

TEACHING THE UNIT

This unit may be taught at any time of year. It demands little preparation. It needs few materials; it is an easy unit to fit into the general programme.

Page 145–146

These pages set the stage for the unit. Boys become concerned with "muscle" at an early age, and girls are dragged into the competition despite themselves. The term "muscle" is no strange one, we need only give it breadth.

Direct experiences, such as those shown here, show the relation of muscles to body movements. A few children may have learned to "flex" their muscles, making them stand out as though they were actively pulling on some object. Many of the children will not have learned to do this; give them something heavy to raise, such as a heavy book like the one shown in the pictures. Then they can feel the muscle harden as it pulls.

Page 147

Children will see in part what muscles are like by examining a piece of fresh, lean meat. Then they can see from a piece of boiled beef that muscles are made up of separate fibres.

A piece of meat may be brought into the classroom for study. The meat should be examined first in a fresh condition and then boiled to show the fibres.

A trip to a meat shop may be planned in connection with this unit. There the children will see a beef carcass with its numerous muscles and some of the common cuts that are made from such a carcass.

Pages 148–149

The children now resume the study of their own muscles. They see from the diagrams how muscles are attached to bones and how they produce movement of the body. They learn the need for two opposing sets of muscles. The muscles in the back of the arm can be felt best when they are actively working. Show the children how to press the back of the hand on the table top while feeling the muscle in the back of the upper arm.

Page 150

The pupils are now ready to find and study other muscles. In addition to the ones shown, a teacher may help them find many others. The muscles that control the fingers are in the lower arm; there are others at the base of the thumb which can be felt by pressing on something with the thumb. The entire arm is lifted by a large muscle covering the shoulder; this muscle can be felt as the arm is lifted upwards from the side. The arm is moved forward and back by muscles in the chest and back.

Muscles in the thighs move the lower legs, muscles in the abdomen and buttocks move the thighs. Muscles in the chest and back move the head.

Some of the simpler exercises used in calisthenics may be carried out and discussed in terms of the muscles involved.

The face has an intricate system of muscles worthy of attention. All facial expressions such as smiling, frowning and the like are caused by muscle action. Eyes can be moved, eyelids raised or lowered, nostrils distended. Some children can even move their ears.

Page 151

The tendons shown on this page are easy to find. Most of them are easy to study, except for those in the hands which are relatively complex.

With a little additional trouble, one may find tendons in the legs of chickens or rabbits as these are being dressed for table use. These tendons may be exhibited to the children and their functions described.

The teacher may wish to recount briefly at this time the classical story of Achilles who was fatally wounded in the heel. The Achilles tendon joins muscles in the lower leg to the heel bone.

Pages 152–153

These pages describe two major types of joints. Hinge joints are relatively easy to understand. Ball-and-socket joints need more than pictures to illustrate their actions. A chicken dinner will provide a thigh bone and a pelvic bone that show clearly how the ball-and-socket joint operates and what its advantages are.

The question of joints other than those shown here will be raised. The motions of the hand as it rotates is more difficult to understand than when a simple joint is involved. Here the two bones in the lower arm move about each other almost as though they were being twisted together. An articulated skeleton is very helpful in answering questions about such motions.

Page 154

In the third-grade unit "Making Things Move" the term energy was introduced and applied in a limited sense to setting things in motion. We now elaborate upon that concept.

The term "energy" as applied to food is commonly used in advertisements. We now show how that energy is used—how it produces muscular motion which in turn can move objects. Ask the pupils to list a number of ways that this food energy is used as it brings about muscular motion. Posters and exhibits of energy-giving foods may be planned at this time, but it is desirable to treat the matter of diet from the standpoint of proper balance, with the energy foods having an important but not exclusive place in the diet.

Page 155

The circulation of blood was touched upon in the second-grade unit "When We Run And Play." At that time the function of the blood was not mentioned. At this level, the pupils can appreciate that some foods such as sugar will dissolve in the blood and can thus be carried to the muscles. The digestion of other foods to make them soluble will be taken up in the fifth-grade unit "Sugar and Starch." It may be well to delay discussion of digestion until that time, lest mere verbalization result.

The work of the second grade on circulation can be reviewed here. Children can note that the heart goes faster when we exercise. They can find veins in their hands. They can feel the pulse in their wrists, arms, throats, and temples.

The effects of tobacco and alcohol on the body may be considered briefly at this time. The chemicals in tobacco and in alcoholic beverages are carried by the blood to all parts of the body. They affect the nervous system. Alcohol acts as a depressant and should never be considered as a stimulant. Doctors and athletic coaches recognize the dangers in these substances.

Tobacco has another unfortunate effect. It decreases the appetite. This is especially important to growing boys and girls, but it affects adults as well in that it tends to discourage the eating of a well-balanced diet.

Pupils should be given these facts about the use of alcohol and tobacco and they should be encouraged to apply the knowledge to themselves. Boys in particular may be interested in the training rules set up by athletic coaches.

Pages 156–157

If the unit on "Balancing Forces" has preceded this one, the children are ready to interpret these pages. If not, it is better to defer these pages until later when they may be treated as an additional application of lever action.

The model shown here is a simple one to make. A similar model can be made from cardboard strips cut in the shape of the bones and hinged together with a brass paper fastener. The children may illustrate a number of levers in the body by this means.

Page 158

Many people do not realize that animals without bones have muscles. The muscles are not evident, because in many animals, like the grasshopper shown on this page, they lie within the hard covering known technically as the "exoskeleton." But anyone who has eaten lobster or crabmeat, has eaten the muscles of these animals.

A large lobster claw with some of the segments attached illustrates how muscles can operate inside the limbs. Such a claw can be kept year after year.

Summary Questions

1. Muscles pull on our bones and make them move.
2. These muscles are in the upper arm.
3. The elbow joint is a hinge joint.
4. The hip joint is a ball-and-socket joint.
5. Energy for moving the body comes from foods.
6. There are two tendons behind the knee and one above the heel.
7. Lean meat is made up of muscle.

Follow-up

Some pupils may like to study some of the topics given in this unit in greater detail. They will find additional information in more advanced science books such as high school biology books and human physiology books. See also the BIBLIOGRAPHY below.

Occasionally, the pupils will hear about broken bones and sprains and strains. Although there is no value in going into all the morbid details of these unpleasant occurrences, they may be used to start a quick review of the learnings presented in this unit.

POSSIBLE LEARNINGS

Muscles make the parts of our bodies move.
Muscles pull but do not push.
Food provides the energy that produces muscular motion.
Many animals have muscles.
Our bones and their joints are levers.

BIBLIOGRAPHY

Books

How Your Body Works. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1949. 160 pages.

A good part on food, its functions in growth, heat, and power.

My Body and How It Works. Dorothy Baruch and Oscar Reiss. Musson: Toronto, 1934. 99 pages.

An explanation of the structure and function of the human body in simple language.

What's Inside of Me? Herbert Zim. George J. McLeod: Toronto: 1952. 32 pages.

A picture book that helps pupils to understand their bodies.

You as a Machine. Bertha Parker and M. Elizabeth Downing. Copp Clark: Toronto, 1951. 36 pages.

How the body is moved and controlled. Includes a section on diet and health practices.

Films

Human Body: The Skeleton. Coronet.

The way in which the skeleton moves and supports the body is shown with the fluoroscope.

Posture Habits. Coronet.
What good posture is and why it is important.

H-64 *Learning About Our Bodies.* Ontario Department of Education.
Basic structure of the human body and how to keep it in good condition.

Airplanes

PURPOSE OF THE UNIT

Airplanes have become as much a part of our environment as birds and flowers. Every well-rounded science programme must give them recognition. This represents no burden to children who find the subject very exciting.

In previous books of this Series there have been many references to airplanes—references which call attention to interesting relationships between airplanes and other factors of the environment such as clouds. This, however, is the first full unit on the subject. It will be followed by a sixth-grade unit dealing with the theory of flight—"How Airplanes Fly."

This work fits into several sequences that run continuously throughout the programme. It builds on previous units dealing with air, attempting to make this commonplace substance seem more real. It is part of a series of units dealing with machines and mechanics. It continues to broaden the concept of energy as introduced in the third grade. It includes activities in the area of weather study, another sequence that has an important part in the Exploring Science Series.

Pupils have many opportunities in this unit to make things, to work with tools, to develop ingenuity, self-expression, and resourcefulness. The activities are of the type suitable for girls as well as boys, and each should be given equal opportunities.

PREPARING FOR THE UNIT

The teacher should try if at all possible to arrange for a trip to an airport. There are many ways the pupils can go. If the airport is within a mile, the pupils may walk there. Sometimes teachers have the children bring their lunches to extend the time that may be spent at the airport. Some schools have school buses that may be used. Many parents who drive are willing to help with these trips.

The materials to be used in teaching the unit are common in most schoolrooms, except those needed for the model airport. For the latter, the only thing at all difficult to procure is the large sheet of construction board needed for the airport base. It may be necessary to purchase this board, but often a sheet may be borrowed from the school shop. The other materials needed for the model airport include paint, cardboard boxes, sheets of construction paper, and model planes.

This unit may be taught whenever it is convenient to visit an airport.

List of Materials

- Sheet of construction board for base of airport
- Cardboard boxes for hangars
- Tracing paper
- Thin cardboard
- Paper clips and scissors
- Poster paints
- Model planes

TEACHING THE UNIT

The unit may be introduced with a trip to the airport, or the trip may be saved until after some basic concepts have been established. Other possible introductions may be built round a flying model which some older pupil has made, or round a film or set of slides.

The vocabulary is not difficult. The only technical word that may cause difficulty is "aileron," pronounced (ā-lếr-ŏn). This word should be introduced carefully and used often until its meaning is clear.

Page 159

In this picture a man is explaining the parts of an airplane to some children. The picture may be used to see how much the children know about an airplane. They may be able to identify the propeller, the wings, the landing gear, the cabin, and the tail of the plane. Some of them may know where the engine is located. Others may be able to name the control surfaces—the rudder, elevators, and ailerons.

Encourage the children to tell about their own experiences with airplanes—what they have seen airplanes do, what airports they have visited, any flights they may have made.

The children may have pictures of different kinds of airplanes they would like to bring in for the bulletin board. Give the children an opportunity to discuss each new type that is displayed.

Pages 160–163

These activities should be carried out by each pupil working individually. The procedures are simple.

The children may trace the outline of the glider on almost any kind of thin white paper. The dotted lines and folding directions should be included on the tracing. After the tracing is done, the lines may be smoothed out and made heavier.

It may be necessary to call attention to the direction at the top of page 161—"Place the straight line on the folded edge." The tracing represents only half a glider, and by putting it on the folded cardboard, both halves of the glider are cut at the same time.

The gliders may be made from any thin and pliable material such as tag board. Used Manila file folders are excellent.

Carbon paper can be used for tracing the outline on the cardboard. It is also possible to lay the tracing upside down on the cardboard and rub it with a straight knife. Enough pencil carbon is transferred to the cardboard by the rubbing to show where the cuts should be made.

Balancing the airplane is a simple process. The paper clip may be moved back and forth until balance is achieved. Sometimes a second paper clip is needed.

Pages 164–165

Once the glider performs well in straight flight, the pupils can make the control surfaces that will enable it to perform complicated manoeuvres. The pupils should not make the cuts for the control surfaces too deep; about half an inch is enough.

The children will have much fun changing the control surfaces. After they have experimented freely, preferably outdoors or in a gymnasium, ask the group to sum up their observations. These may be checked against the performance of a single glider while everyone watches.

Use the names of the control surfaces repeatedly so that the pupils will associate the words with the proper surfaces.

Pages 166–167

Here the control surfaces on a real airplane are named and the means of moving the control surfaces are explained. Have the children find the control surfaces on pictures of other types of planes and on models that the pupils bring in.

It is at this time that a trip to an airport is especially appropriate. Try to make arrangements to have the children taken up close to a plane so that the control surfaces can be seen. Often the guide will go inside the plane and make the surfaces move. Sometimes, if the class is small, he will take one or two children at a time into the cabin and show them how the control surfaces are moved.

Pages 168–169

The energy concept as applied to airplanes does not introduce any new ideas at this time. The children learned in the third-grade unit "Making Things Move" that energy can be stored in twisted rubber bands and that gasoline contains stored energy.

If possible, ask some older boy who has made a flying model to demonstrate it to the class.

Pages 170–171–172

The extent of the work done on the airport will depend upon the interest of the children, their ingenuity, and the time that is given them by the teacher. Sometimes these airports become very elaborate, being equipped with beacons and landing lights as well as with the facilities pictured here. Since children usually prefer to make the model follow the pattern of the airport that they visited, specific directions for an airport are not given in the text.

Children may be curious about why airplanes head into the wind when landing and taking off. Explain that the faster the wind blows under a wing the greater is the lifting force on the wing. Therefore, the plane need not move so fast (in relation to the ground) to climb or stay up in the air when it heads into the wind.

Summary Questions

1. The children should describe the straight flight of a well-balanced glider, or they may mention resting the tips of the wings on their fingers. See pages 162–163.

2. If the pupils have played with model planes at their model airport they will know that airplanes head into the wind when taking off and landing, so landing strips are laid out along the lines of the prevailing winds.

3. The pupils probably know that the rudder of a boat steers the boat and they quickly apply this knowledge to airplanes.

4. Many pupils may not know the answer to this question unless they have been in a plane and have seen the ailerons moved. The text tells them that the ailerons are moved by turning the wheel. Some pupils may know that in certain planes, usually small planes, a control stick replaces the wheel, and the ailerons are moved by pushing the stick from one side to the other.

5. The work of this and previous units should make the pupils conscious of the importance of weather to pilots. The direction and strength of winds is important. The height, thickness, and kind of cloud cover is also important.

6. Airplanes with which most pupils are familiar get their energy from gasoline. Jet planes, however, use other fuels.

7. Children usually do not have difficulty understanding that the elevator of an airplane turns the nose up and down. There are other factors, such as change in speed, that make a plane rise or settle in the air, but these are studied in "How Airplanes Fly" in Book Six.

Follow-up

After this unit has been studied pupils often like to make model planes from kits sold in hobby shops and variety stores. They usually do not have the ability to make flying models at this age, but they can make scale models. If such models are made and brought to school, give the pupils who made them opportunity to describe the planes they represent. If enough models are made, arrange for an exhibit.

From time to time pictures showing new types of planes or special features of planes or airports can be posted on the bulletin board.

There are usually many happenings locally or on the national scene that children enjoy knowing about. A few minutes given to these topics now and then keep the understandings developed in this unit alive and meaningful.

POSSIBLE LEARNINGS

Airplanes and gliders have wings.
Airplanes are controlled by three sets of surfaces.
Airplanes need energy to fly.
Weather is important to airplane pilots.

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Books

Big Book of Real Airplanes. George Zaffo. George J. McLeod: Toronto, 1951.

Pictures of types and parts of an airplane and explanations on safety.

First Book of Airplanes. Jeanne Bendic. Ambassador Books: Toronto, 1952. 69 pages.

Contains history of aviation, how a plane flies, and much about pilots.

Model Planes for Beginners. Horace Gilmore. Musson: Toronto, 1947. 95 pages.

How to build airplanes and keep a good workshop.

Wonderful Plane Ride. Ruth Weir. W. J. Gage: Toronto, 1949. 33 pages.
Much information given in story form.

Films

An Airplane Trip. Encyclopaedia Britannica Films.
An interesting film of a trip from Los Angeles to Salt Lake City, including servicing of the airplane and the operation of the controls.

SS-151 The Airport. Ontario Department of Education.
This film illustrates the normal activity at a large airport.

A Hand Lens

PURPOSE OF THE UNIT

Magnifying lenses are thicker in the middle than they are at the edges. The type used in hand lenses is known as a double convex lens. Such lenses are widely used in devices ranging from eye-glasses to giant telescopes. Previously in this Series we have suggested many activities in which these lenses can be used for magnification. The children are now ready to study other characteristics of such lenses.

The unit forms a part of the sequence in this Series dealing with light, building on the second-grade unit "Mirrors," and the third-grade unit "Sunshine." The directional nature of light, stressed in the unit on mirrors, is here continued and expanded. The heating effect of sunlight is also continued in the activity on page 184 in which the lens is used as a burning glass.

The material of the unit has many immediate applications to such devices as cameras, picture projectors, miscroscopes, and telescopes. The sixth-grade unit "Our Eyes" will build directly on this work with lenses.

Subject-matter understandings are but a part of the valuable outcomes we can expect from the study of lenses. The emphasis in the unit is upon manipulation with all the important sensory achievements resulting from this type of activity. Children are given opportunities to follow directions, another valuable type of training. And of great importance is the stimulation this unit gives in making pupils aware of the things about them.

PREPARING FOR THE UNIT

The chief requirement for this unit is a number of hand lenses, preferably one for each pair of pupils. It is possible to get along with fewer lenses but at the expense of individual participation.

Another requirement is a room that can be darkened, the more completely the better. Many schools have a room in which motion pictures and lantern slides are shown. Sometimes a dark basement room is available. Failing either of these, it may be possible to wait for a very dull day, when, with the shades drawn, the classroom becomes fairly dark.

For the homemade picture projector, a four-inch hand lens gives better results than the smaller two-inch lenses which are satisfactory for most other uses. The former also acts better as a burning glass.

A box camera that can be taken apart helps to enrich the study of cameras. A focusing camera with a ground glass back is useful to show how a camera is focused. Picture projectors of various types show other ways that lenses are used.

Additional materials include candles, an electric lamp cord, a round fish globe, a straight-walled drinking glass, a rose bowl. One may also add to the list such things as a clear glass marble and a glass towel rod.

List of Materials

Hand lenses
Candles
Electric lamp with guard
Lamp cord with plug and socket
Cardboard carton
Candy box
Wire
Sand
Tape
Box camera
Slide projector
Fish globe, rose bowl and other spherical containers
Drinking glass
Pan

TEACHING THE UNIT

This unit is flexible. After the first three pages have been taken up, the remainder may be treated in any order, depending upon the facilities and upon the interests of the pupils.

Pages 173–174–175

These pages direct the first basic experiences. Most of the pupils will have used a lens to magnify things they are looking at. Many of them will have noticed that a lens held at arm's length makes things look smaller and upside down. Be sure that all the pupils have had this experience before going on.

The children may be interested in measuring the magnification power of a lens. Direct them to focus a lens on sheets of lined paper. Then show them how to find the number of spaces seen outside the lens which correspond to the width of a single magnified space seen through the lens. Most lenses of this type magnify about two times; that is, the width of two spaces seen outside the lens corresponds to the width of one space seen through the lens.

Page 175 describes an experience which few children at this level have had. Let every pupil carry out the activity. Allow plenty of time for experimentation.

For best results, the room should be darkened except for the one window, and a bright day should be chosen.

Pupils like to repeat this experience. Leave a hand lens and a sheet of white cardboard where they can use them during their free time.

It is difficult to explain why a lens works because so little is known about the nature of light. It is better to accept the characteristics of a lens—just as we accept the characteristics of a magnet—and allow the children ample time for becoming familiar with these characteristics.

Pages 176–177

Although the material on these pages may be covered in one lesson, the activities described permit so many variations that two or even more lessons may be allowed. One must be guided by the ease or difficulty of obtaining a darkened room.

It is probable that most teachers will prefer to treat these pages by the demonstration method, giving different pupils the opportunity to carry out the variations of the experiments. In demonstrations of this type, the teacher must be sure that all pupils can see everything that goes on. If a four-inch lens is available, the images formed will be brighter and more vivid to the entire class than if a small lens is used.

In carrying out the activities, first review the learnings of the previous page in which an image was formed by the lens. Then try to produce an image of the candle on the cardboard. Unless the candle is too close to the cardboard, the pupils will find two different positions in which the lens produces an image. One of these positions results in a small image, the other position results in a large image.

Next the children may experiment with changing the distance between the candle and the screen. They will find that if the distance between the two is increased, the sizes of the images formed will be changed. The image formed by the lens in one position will be smaller. The image will be larger with the lens in the second position. If the room is very dark, greatly enlarged images of the candle flame can be produced.

The candle may be replaced by an electric lamp, and an image of the lamp will be produced on the screen. If one can find an unfrosted glass bulb, an image of the filament will appear on the screen.

The last activity shown has many variations. An image of the hand can be produced on the cardboard if the room is dark and the lamp is bright. In place of the hand, one may use a brightly-coloured picture. Try shielding the screen from the direct rays of the lamp by holding a small piece of cardboard in front of the lamp; then the image of the picture can be seen better.

Coloured cellophane or glass held before the lamp will produce a coloured image on the screen. A large, coloured lantern slide held in front of the lamp will show the principle of the slide projector.

Pages 178-179

This simple picture projector delights pupils more than expensive commercial projectors. Many pupils will make them at home, devising many ingenious variations as they do so. During the construction they will be developing invaluable skills in following directions and in manipulation. Be sure the girls have opportunities equal to those of the boys.

The purpose of the inner box is to shield the lens from the direct rays of the lamp. A cereal box or a deep candy box is excellent. If the pupils question the purpose of the inner box, let them set up the projector without it and see what happens.

To produce a good image use as large a hand lens as possible; a lens with a four-inch diameter gives good results. A bright lamp will give a brighter image than a dull lamp. Lamps of 100 and 150 watts are excellent but they heat the cardboard a good deal. If one of these bright lamps is used, it is well to line the box near the lamp with sheet asbestos to reduce the danger of fire.

The projector is focused by moving the picture back and forth inside the box, and it will probably be necessary to experiment with the distance between the projector and the screen. A short distance gives a brighter, although smaller, image.

Page 180

The exploded diagram on this page shows the fundamental parts of a camera. If possible, show the pupils a similar camera. A box camera can be put on display for the pupils to examine during their free time.

A focusing camera with a ground glass back is helpful. Set the shutter on "time" and open it. Then, with the camera pointed toward a window, move the lens back and forth to produce an image on the ground glass. If the other windows are darkened, the image will show better.

To enrich this page still further, take some pictures of the children, discussing at the same time how an image is being produced on the film—just as an image was produced in the experiment on page 175. Then when the pictures have been developed and printed the children can discuss again what happened.

Page 181

The exploded diagram on this page shows the fundamental parts of a slide projector. If possible, show the children a projector. Take off the top of the lamp housing to show the lamp. The children may also see a mirror that helps direct light towards the slide. Show them where the slide is placed, and then show them the lens.

Permit the children to project a few slides. They will quickly learn that the slides must be put in the projector upside down. Refer them to their earlier work with images (pages 173–177) for an explanation.

Perhaps it will be possible to show the children other types of projectors. Movie projectors, opaque projectors, film strip projectors, and the like have the same fundamental parts.

Pages 182–183

We now call attention to the shape of common magnifying lenses. Then we try to develop the pupils' habits of observation by encouraging them to look for other objects that magnify. In addition to glass bowls and flasks, the pupils should look at clear glass tumblers filled with water, clear glass marbles, glass towel rods and the like. Drops of water on a window pane show inverted images. A drop of water in a tiny loop of wire serves as a magnifying lens.

The effect of putting objects in round glass vessels of water is amusing. Encourage the children to look for other examples of this magnification.

Page 184

In this activity, a four-inch lens concentrates more sunlight on a single point than a smaller lens does. The heating effect is consequently greater.

Note that the paper is being burned in a metal pan which has been filled with sand. Ask the pupils to discuss precautions they should take.

In discussing the heating of the paper, use the term "energy" in the explanation of why the paper becomes hot. This is the first time that heating effects are explained in terms of energy.

Summary Questions

1. The children will probably describe the hand lens as being thicker in the middle than round the edges.

2. The activities of the first section of the unit have shown the pupils that a hand lens can magnify, that it can make objects look smaller and upside down, and that it can make a picture on a screen.

3. This unit has shown the pupils that cameras and picture projectors use lenses. Their own experiences may enable them to add to the list such things as field glasses, telescopes, and microscopes.

4. The pupils should describe the activity illustrated at the top of page 184.

5. The pupils may suggest looking at the goldfish with a hand lens or putting the goldfish in a round bowl of water.

Follow-up

When using magnifying lenses and picture projectors there are opportunities for referring to the lenses—both to their shape and to what they can do. On occasion, some of the activities described in this unit may be repeated.

POSSIBLE LEARNINGS

A hand lens can magnify, produce an image on a screen, and make distant things look smaller and upside down.
Magnifying lenses are thicker at the centre than round the edges.
Magnifying lenses are used in many devices that produce images.

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Books

Experiments in Optical Illusion. Nelson F. Beeler and Franklyn M. Branley. Ambassador Books: Toronto, 1951.

How our eyes play tricks on us, demonstrated with activities and experiments.

Films

Light and Heat. Gateway.
Illustrates reflected and refracted light and shows what light and heat do for us.

Soil

PURPOSE OF THE UNIT

Our soil is one of our greatest natural resources. We must learn to use it wisely and stop the shameful waste of it.

Wise use of soil depends upon understanding. An intelligently conceived national policy towards soil conservation requires an informed public. Schools can assume much of the task of developing the understandings and providing the information which the public needs.

In the Exploring Science Series we have continually stressed the relationship between plants and soil. In the third-grade unit "Muddy Water," experiences were given with the causes and prevention of soil erosion. In this unit, we begin to develop an appreciation for the complex interrelationships within the soil.

The content fits into the sequence of rock and soil study. It deals with the mineral content of soils and the breakdown of rocks into soil. It also depends upon and gives meaning to experiences in the area of plant study, dealing as it does with soil water and the dissolving of soil minerals in the water. Non-green plants are also mentioned briefly, introducing a subject that will be considered more thoroughly in "Plants That Are Not Green" in Book Six.

The unit deals with the relationships of organisms and their environment. The effect of the soil on plants and animals and the effect of the plants and animals on the soil is considered. All this hints at the delicate balance of life which, it is hoped, every pupil will begin to appreciate before he becomes an adult.

PREPARING FOR THE UNIT

This unit can be taught at any season which permits a class to go outdoors for explorations. Early fall and late spring are satisfactory.

If several types of soil are not immediately at hand, it is desirable to collect before the unit opens such soils as clay, sand, gravel, and loam. For equipment, the class will need hand lenses, glass jars, bottles, flower pots, metal cans, a hammer, and an electric hot-plate. A low-power microscope is helpful but not essential.

List of Materials

Garden soil
Glass jar, gallon size
Hand lenses
Pint glass jar with screw top
Soft rock or brick
Hammer
Heavy cloth
Large, flat rock
Samples of rock
Hot-plate
Metal cans
Aquarium with glass top
Flower pots

TEACHING THE UNIT

Although this unit shows one possible organization of the material, there are others equally good. It is possible to begin with a study of the animals in the soil, or with fertilizers, or with water erosion. Local conditions, unexpected events, and pupil interests will determine the treatment of the material.

Try to use field work as much as possible. Soil brought into the classroom is little more than a mass of particles of rock material. Soil in gardens and in fields, however, is much more. It is ever changing; it has definite structure; it contains vast numbers of organisms, both living and dead; it affects, and is affected by, the things around it and within it. Although children cannot begin to appreciate all these complex factors,they can begin to observe and wonder about some of them.

Page 185

This page can be used to introduce the unit, or it may be used as a discussion page late in the unit. Discussion of the page may include some of the following questions.

What is happening in the picture? Why does the man plough the field? What crops might he plant? What are some of the crops that would provide us food? What kinds of animals do we eat? Where do these animals get their food?

What are the cows doing? Name some other animals that eat grass and other plants (not forgetting creatures such as caterpillars and grasshoppers). What must the grass and the other plants have in order to grow?

What are some things we might find in the soil? What is the bird looking for? What other animals eat living things that they find in the soil?

Page 186

This activity crudely sorts soil into some of its components. Light materials float, pebbles drop to the bottom immediately, and finer particles settle out slowly. Pupils enjoy doing this type of activity over and over. They may try different kinds of soils such as garden soils and woodland soils. The concepts being developed apply not only to the present unit but also to later work with stream deposits.

Page 187

The types of soils illustrated here are typical soils. Some regions have other types such as muck soils and peat soils. Loam is the most common agricultural soil, containing enough sand to keep it loose and enough clay to help it retain moisture and have texture.

If there is enough variety in local soils, collect some of the different types and put them in labelled glass jars. Trips to see soil types may be taken. The local agriculture teacher or governmental agent may be able to tell where different soils can be found.

Page 188

For the experiment showing that rocks are worn down in moving water, use rock materials that are as soft as possible. Shale and some soft limestones are excellent. Where no soft rocks are available, bits of broken bricks can be used, but the children should realize that they wear more rapidly than most rocks.

The rocks should be shaken many times to produce observable results. The children may take turns shaking the bottle, each one shaking it a hundred times until the rocks are well worn. There should be frequent stops to note the appearance of the water and to take out pieces of rock for examination.

Finally, the bottle should be allowed to stand while the mixture settles. Then the children will see that a type of soil has been formed and that the bottle itself is worn. They may filter the water and recover the soil.

Page 189

Wherever rapid streams run through rocky country, one will find stones rounded by water action. Stones of wave-worn beaches also are rounded in the same fashion.

If there is a stream or a beach near the school, organize a trip to collect rounded stones. Bring back specimens for display. If a trip is impossible, try to procure specimens for the children to study in the classroom.

Page 190

A type of soil can be produced in the fashion shown here. Try to find a soft rock, preferably sandstone, that crumbles up rather easily. Let the children crush this rock to form a sandy soil. If they cover the bits of rock with a heavy cloth, the bits of rocks will not fly about.

With most rocks, this type of soil is not very fertile; it will not supply the minerals which most plants need. The children should be encouraged to speculate about the reasons for this—to suggest that there may be more in soil than just broken bits of rocks.

The experiment suggested may not give positive results if the soil that has been made from rocks is fertile. Usually, however, the plant growing in garden soil does better.

Page 191

This exercise on the relative strength of rocks gives an opportunity to introduce some of the common rocks of the region. When the teacher does not know the names of the rocks, there may be some science teacher or an expert in local geology to give some help.

The concept of degrees of strength is useful in studying rock erosion, although there are other factors, such as solubility, which also affect erosion. Call the attention of the pupils to evidences of different rates of erosion when they are on trips or when they are looking at pictures of rock ledges.

Pages 192–193

We should not forget two of the most important components of the soil—air and water. That water exists in soil, no matter how dry it seems, can be demonstrated as shown here. The value of water to plants can be discussed. The source of the water and its movement in the soil can be touched on, but these topics will be treated in greater detail in later units.

The presence of air in the soil is easily shown as bubbles rise through the water that is poured over it. The pupils will recognize the importance of the air to the animals that live in the soil. They may not realize, however, that plant roots need air also. By keeping the soil round the roots of a plant saturated with water so that air is kept out, the children will discover that the plant cannot live.

Pages 194–195

Many people never appreciate the importance of humus in soil and the role of the numerous organisms that produce humus. At this level we will do little more than touch upon this aspect of soil relationships. However, we will attempt to make pupils conscious of humus and its value.

Most of the organisms which cause the decay of plants are microscopic, and pupils must take our word for their existence. Some of the larger fungi, such as those that produce mushrooms, are big enough to be studied. Children should realize that the mushrooms themselves are the reproductive parts and that the plants themselves are within the decaying material. Perhaps the class can be shown a piece of rotting wood, which, when torn apart, shows a network of shining threads that are the mushroom plant.

The breakdown of dead organisms releases many important chemical compounds such as nitrates and phosphates. These chemicals dissolve in the soil water and pass into plant roots.

If there is a pile of leaves or a compost heap near the school, visit it to see evidences of the process of this breakdown into humus. Many gardeners and greenhouse operators use some such source for the humus they give their plants. One of these men may be willing to explain the importance of humus and the methods by which he obtains it. A visit to a woodland permits observation of various stages of humus formation and incorporation into the soil.

Humus generally darkens soil and gives it a looser texture. If possible, take the class to a garden and dig down until a layer of lighter-coloured soil is reached. This latter layer is called subsoil; it contains little humus and is not suitable for most plants. Perhaps pupils will have had experiences with the purchase of topsoil containing humus for lawns and flower beds.

Pages 196–197

Earthworms, sometimes called “fishworms” and “angleworms,” are known to most children. It is believed that earthworms play an important part in keeping the soil open to air and rain water, and in mixing the soil so that humus penetrates deeper.

Earthworms can be kept in the classroom as described. They need a cool temperature; many classrooms are too warm for them. There is also danger that the soil be watered so heavily that the earthworms drown.

Pages 198–199

Moles and shrews are much more common than most people realize. Their habits keep them out of sight most of the time. When they are seen they are usually mistaken for mice.

Occasionally a mole or a shrew is caught alive and brought to school. It is difficult to keep one of these animals alive in captivity. The best plan is to give it water, keep it a short time, and then let it go.

The pupils should notice the chief external characteristics of moles and shrews, either from live specimens or from the pictures. These animals have no observable external ears, their eyes are tiny and may do little except distinguish between light and dark, and their noses are long. The front feet of the moles are worth study; they are well adapted to digging in the soil.

Page 200

Here are a few of the many animals that can be found in the soil. A compost heap or a pile of decaying leaves usually contains a large number of these organisms. They may also be found in woodland soil and around rotting wood.

Summary Questions

1. The discussion of the first page of this unit together with work in previous grades should have established in the minds of the pupils our dependence upon plants, which in turn are dependent upon the soil.

2. Soil is formed primarily by the breakdown of rocks. Pupils should recognize this fact from the experiments they have carried out. Encourage them to mention other things that help to make up the soil such as humus, live and dead organisms, air and water.

3. The pupils may use the word "rot" or "decay" in describing the breakdown of organic matter. They may also speak of bacteria and mushroom plants as agents of decay. Some of the pupils may appreciate the role of plant-eating animals such as some of those at the top of this page.

4. The pupils may name any of the animals listed in this unit such as moles, shrews, and earthworms, together with others from their out-of-school experiences, including woodchucks and ground squirrels.

5. The soils listed in this unit are gravel, sand, clay, and loam. Pupils may know of other soils such as muck and peat soils.

6. The role of humus in making the soil looser, in holding moisture,

and in providing needed minerals should be understood in some degree by the pupils.

Follow-up

After the formal work of this unit is over, there will be almost endless opportunities to keep the children thinking about soil and soil relationships. The care of house plants, the planting of gardens, farming practices, and forestry involve the soil. The pupils may be encouraged to discuss the characteristics of the soil when they are considering the above activities.

Many field trips taken in conjunction with other subjects will provide unexpected situations that may be utilized. Perhaps the way leads along a newly cut bank that shows the division between the topsoil and the subsoil. Or in a woods the children discover that the soil cover is made of decaying plant material.

As pictures that show soil erosion and rock erosion are discovered they may be put on the bulletin board for a short time. Children that go on trips with their parents often find materials appropriate to the unit, such as samples of new soils. These may be exhibited. It is not necessary that teaching be confined to the formal class periods; some of the best learning comes from incidental teaching situations.

POSSIBLE LEARNINGS

The soil is very important to us.
Soil usually develops from broken rock materials.
Streams help change rocks into soil.
Humus, from decaying organisms, makes soil much better for plants.
Air and water are important parts of the soil.
Many animals live in the soil.

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A beginner's book of mineralogy.

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Answers many questions about rocks and soil.

Pogo's Farm Adventure. Josephine Norling. Clarke, Irwin: Toronto, 1948. 46 pages.

A story of soil, its value, and care.

Rocks, Rivers, and the Changing Earth. Herman and Nina Schneider. S. J. Reginald Saunders: Toronto, 1952. 181 pages.

A book written to explain the story of our earth.

Films

Birth of the Soil. Encyclopaedia Britannica Films.

Soil formation from basic rock materials with the aid of processes of growth and decay.

Understanding Our Earth: Soil. Coronet.

How soil is formed and why it should be conserved.

Water in the Soil. Encyclopaedia Britannica Films.

Turtles and Other Reptiles

PURPOSE OF THE UNIT

It is the plan of the Exploring Science Series to include each year several life history studies. A life history study is an excellent means of acquiring a true appreciation of an organism—what it does, where it lives, how it is adapted for survival, how it is related to its environment. The understandings so gained are essential for developing desirable attitudes towards living things.

The life history studies are chosen to give an acquaintance with representatives of the major groups of organisms. In this unit the turtle represents the reptiles. After studying the turtles, pupils can make comparisons with other reptiles. From the pupils' viewpoint there is not much evidence of a relationship among such diverse groups as alligators, turtles, and snakes. Similarities in scaly covering and in eyes may be pointed out, but the basic similarities are mostly internal and not observable by children.

A portion of the unit continues the study of egg-laying, egg development, and parental care, building on the second-grade unit "Birds' Eggs," and on the third-grade unit "Toads and Frogs." This is part of the sequence in reproduction and sex education.

Part of the unit deals with structures of reptiles. Several important adaptations are noted and the foundation needed for a study of relationships is expanded. But as yet there is no discussion of the significance of adaptations and structural relationships. Pupils need many more experiences and greater maturity before entering into such discussions.

Much of the unit deals with the part that turtles and snakes play in their environment—the organisms they feed upon, the organisms that prey upon them, and their interaction with the physical environment.

In regions where there are poisonous snakes, teach the pupils to recognize the dangerous forms through pictures and museum specimens if available. Do not build up an unreasoning fear of the snakes; terror may lead to tragedy when calm thinking would have prevented harm. Teach the pupils as much as you can about the habits of the poisonous forms—where they are found, how they react to danger, and how to avoid them. Teach them also what to do if bitten, and stress the low fatality rate among those bitten by snakes. Doctors and first aid experts may be willing to help with this.

PREPARING FOR THE UNIT

With the coming of cold weather, turtles burrow into the mud and become inactive. This unit, therefore, is best studied in early fall or late spring. Interest is usually highest just after a live turtle has been brought in. If there seems no possibility for acquiring a native turtle, one may be purchased at a pet store. Should this turtle have paint on its shell, scrape off the paint with a dull knife to restore it to its natural appearance.

To keep a small turtle in captivity, one needs a large aquarium and a pan to fit inside, as described on page 206 of this unit. Feed the turtle live flies, live earthworms, and bits of meat. Some turtles will eat prepared turtle food.

Big turtles should be kept in a tub. It is recommended that big turtles be kept for two or three days only. For this short period the turtles do not need food but they will need water. Many aquatic turtles need enough water to crawl in; land turtles need a dish of drinking water.

Sometimes a turtle shell is picked up and brought to school. This may be sawed apart along the sides to show how it is attached to the bones of the turtle.

Pupils often bring in snakes and these may be kept a short time for study. They are best kept in dry cages. Give each one a dish of clean water for drinking and for crawling through. These snakes will probably not eat in captivity, so keep them only a day or so.

List of Materials

Turtle
Large aquarium or terrarium and pan to fit inside

TEACHING THE UNIT

When possible, use a living turtle to introduce the unit. Turn to the book after the children have made spontaneous observations of the turtle's structure and behaviour.

Page 201

This title page illustrates an experience common to anyone who has visited shallow ponds. It tells a story for discussion and interpretation. Pupils who have had similar experiences should be encouraged to relate them at this time. The turtles shown on this page, and in the rest of the unit, are known as "painted" turtles. They are so called because of their bright colours.

One must be ever alert to the danger of letting the pupils give to turtles the power of thinking in human fashion. There is no evidence that turtles reason as we do. Indeed, there is much evidence that turtle intelligence is of a very low order.

Turtles apparently react chiefly by reflex. When there is sudden motion or a vibration of the earth, the turtles dive into the water much as we blink our eyes at sudden motions. Their other acts of self-preservation are probably reflex actions too.

Pages 202–203

To make these pages most effective one should have a live turtle to watch. An empty shell is also helpful.

Encourage the pupils to study the structure of the shell. The pupils will see that the shell is made of many small pieces fastened together. They may count the sections in the upper part of the shell and in the lower part. They will see that the lower part is tightly attached to the upper part.

Ask if the pupils think a turtle can crawl out of its shell. They will learn the answer on the following pages.

The shells of turtles vary with the species. Snapping turtles have so small a lower shell that they cannot crawl inside at all. Box turtles, on the other hand, can crawl completely inside and even close the front of the shell to some extent. Most turtles' shells fall between these extremes.

It is to be hoped that teachers will not encourage the children to make such statements as "Turtles carry their homes around with them." A turtle's shell is no more a home than are our hair and finger-nails.

Page 204

An empty shell that can be sawed apart is most helpful in showing the pupils how the shell is attached to the ribs and backbone of a turtle. The pupils see immediately that the turtle's shell is part of the turtle and not something it can crawl from at will.

Direct the children to study the hind foot of a living turtle if one is available. A turtle's hind foot is shown at the bottom of page 204. **Can you find the web and claws? Do the front feet also have webs and claws? How many toes are there on each foot? Note the scales on the legs. What other animals have scales?**

Page 205

The nature of a turtle's jaws can best be determined by comparing this picture with a living specimen. The lack of teeth and the hard edges of the jaws are readily apparent. It will be helpful if the children can watch a turtle eat.

Turtles eat a variety of foods. Small living animals probably make up the bulk of the diet of water-living species. Aquatic turtles also feed extensively on dead animals and some eat vegetation. Land turtles eat much plant material.

By putting live but injured flies on the surface of the water, the children may see how a turtle captures its prey.

Page 206

This page shows a terrarium well adapted for small turtles. The aquarium need not be watertight: it may be one that is cracked or has developed a leak.

If a turtle is kept in an aquarium with water in it, be sure to provide a rock or a float on which the turtle can climb to sun itself.

Small turtles of the aquatic type eat earthworms, soft-bodied insect larvae, and chopped beef. They must be fed in water, which they seem to need to swallow the food. Feed them once a day and give them only as much as will be eaten. Remove uneaten food so that it does not spoil.

Page 207

This activity provides an opportunity for the pupils to develop powers of observation and self-expression. Turn the turtle over on the floor in front of the class. Then ask the pupils to describe exactly what the turtle does. Compare their statements with the pictures on this page.

Use this occasion to develop a feeling of humaneness for the turtle so that the children do not insist upon turning the turtle over again and again. Help them realize that when they have a pet they have important responsibilities to prevent needless suffering and discomfort.

Pages 208–213

These pages describe the general aspects of the reproduction of painted turtles. The egg-laying process of other common turtles follows the same pattern. There is enough food stored in the yolk to last a young turtle several days, during which time its shell hardens, its muscles strengthen, and it develops the ability to dig its way from the ground. The yolk is gradually absorbed, and it disappears by the time the young turtle is able to take care of itself. Ask the children to read and tell in their own words the story shown here. Question them about the content of the pages.

Page 214

Many children express a horror of snakes. This is understandable considering the large number of stories, generally untrue, about the bad features of snakes. It is possible to break down this strong feeling against snakes by awakening an interest in the snakes as living animals. Most snakes are harmless and some are considered beneficial; only a few are poisonous and few people are ever harmed by them.

Harmless snakes (like the garter snake shown on pages 214–216, and bottom page 217) that are brought into the classroom should be put in a dry cage where the children can watch them. The children should note the scales and compare a snake's head with a turtle's head. They should note whether or not it breathes and how it moves about. (The word "reptile" is defined on page 23 of this Manual.)

Page 215

Some people believe that a snake's tongue is its "stinger." Explain that this is a soft tongue. Snakes have teeth with which they bite.

Poisonous snakes have special grooved teeth (fangs) through which they inject poison as they bite. Explain, too, that most snakes do little harm even when they bite someone, and that only a few kinds can poison anyone they bite.

If there are poisonous species in the region, use pictures to show how poisonous snakes can be identified.

The feeding habits of snakes are interesting, but children tend to expend their sympathy on the animal being eaten. Try to develop in children an impersonal attitude towards the predator and its prey—"It is too bad for the frog but good for the snake."

Page 216

The movement of a snake over the ground seems truly remarkable to us who depend upon legs for motion. It is based, however, upon some rather simple techniques made graceful and flowing through a marvellous muscular co-ordination.

To help the pupils understand the process use a toy snake or a piece of rope to illustrate the description given here. Then if a live snake can be watched, the method of locomotion should be apparent. It is through such a study that a genuine interest comes to replace a feeling of aversion.

Page 217

This page illustrates the two types of reproduction common among snakes. The one method, egg-laying, is similar to that of turtles. The eggs are often deposited in rotten wood or under stones. The other method is encountered in a few other animals such as fish—guppies, for example—and some insects. In general, snakes with smooth scales, such as milk snakes and black snakes (and king snakes shown at the top of the page), lay eggs; snakes with "keeled" scales, such as garter snakes (shown at the bottom of the page) and water snakes, retain the eggs in the bodies of the females until they are hatched.

Page 218

Alligators and lizards are reptiles. On this page are shown three lizards as well as an alligator. Note that the horned toad is a lizard, not a toad. In some regions, one or more of these animals is common enough to deserve further study.

Children are apt to call salamanders "lizards." Salamanders, which are amphibians, are smooth-skinned and often slimy. Lizards have scales like snakes.

Summary Questions

1. The pupils may describe how a turtle attempts to dive into water if it is nearby, and how the turtle withdraws into its shell when escape is impossible.

2. From their reading, and from their experiences feeding turtles, the children will name a variety of foods. In general, turtles eat small living things, the flesh of dead animals, and some vegetable matter.

3. The pictures in the text show that turtles lay eggs in holes which they dig in the soil.

4. The text mentions foxes, skunks, raccoons, crows, gulls, and hawks as feeding on small turtles and turtle eggs. The children may have read about other animals that they can add to the list. These animals may find the eggs by smell or by noticing the disturbed earth.

5. The unit makes a point of showing that snakes do have bones.

6. See if the children can describe in their own words the process explained on page 216. It would be acceptable to let them supplement the description by drawings or by manipulating a piece of rope.

Follow-up

If a turtle or a snake is kept in captivity, part of the follow-up will include the care of the animal. As other specimens are brought in, take a little time to study them, especially if a new species is represented or if there is something unusual about the specimen. Pictures on the bulletin board, accounts of new experiences on the part of pupils, and display of new specimens help to keep the topic before the children.

POSSIBLE LEARNINGS

Turtles, snakes, alligators, and lizards are reptiles.

A turtle's shell is part of its body.

Turtles feed upon small, living animals, upon the flesh of dead animals, and sometimes on vegetation.

Turtles try to escape danger by diving into the water or by withdrawing into their shells.

Turtles lay their eggs in soil and give no further care to the eggs or the young.

Some snakes lay eggs, some keep the eggs inside their bodies until they develop.

Snakes have bones.
Snakes feed on animals which they swallow whole.
Snakes shed their skins in one piece.

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The adventures of a three-legged snapping turtle.

Reptiles. Bertha Parker. Copp Clark: Toronto: 1942. 33 pages.
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Explains reproduction, growth, movement, and values of snakes.

Turtles. Wilfrid Bronson. W. J. Gage: Toronto, 1945. 63 pages.
A simple book to delight and inform.

Wild Folk at the Pond. Carroll Fenton. Longmans, Green: Toronto, 1948. 127 pages.
Tells of turtles and snakes and their friends and foes.

Films

Snakes. Coronet.
Illustrates habits, locomotion, nutrition, and self-protection, and warns against the four types of poisonous snakes.

Snakes Can Be Interesting. Young America Films.
Life cycle of the bull snake and interesting material about other snakes.

Snapping Turtle. Encyclopaedia Britannica Films.
The life history of this reptile in its natural habitat.

List of Science Materials

(Class of Thirty Pupils)

NUMBER	ITEM	REMARKS
2–15	hand lenses	low power, needed in every grade
1	thermometer	household
2–15	magnets	type used in first grade
1–2	aquariums	rectangular, medium-sized
1–2	fish globes	2-gallon approximate
1	hot-plate	or other source of heat
1–2	hammers	
1	saw	cross-cut
2–15	scissors	blunt ends
1	knife	sharp paring knife
2–6	spoons	inexpensive
1	tape measure	50 or 100 foot
1	apple corer	
1	electric lamp	"trouble" lamp with guard and cord
1	geography globe	
1–3	bicycles	borrowed from pupils
1	box camera	can be borrowed
1	model truck	borrowed from a pupil
2–6	model airplanes	borrowed from pupils for model airport
1	slide projector	type used in school
1	seesaw	on playground or made from plank and saw-horse
1	beam scales	type used for weighing children (if possible)
1	AM radio	table or portable, may be borrowed
2–3	glass jars, gallon	mayonnaise or pickle
2–6	glass jars, quart	with screw tops
2–6	glass jars, pint	with screw tops
6–15	glass jars, half-pint	with screw tops
6–10	bottles, half-pint	with caps or corks

NUMBER	ITEM	REMARKS
2–6	drinking glasses	clear glass
2–4	vases	jars can be used
2–10	milk bottles, quart	
6–10	plant pots	assorted sizes
1	large pitcher	can be borrowed
	tin cans	assorted sizes
1–15	panes of glass	4″ x 4″
1	pan	shallow to fit in aquarium
	cardboard cartons	several sizes
30	thin cardboard	used Manila folders suitable
30	tracing paper	8½″ by 11″
30	mimeo paper	8½″ by 11″
	gummed labels	1″ by 2″ approx.
	gummed tape	2″ wide
	paper towels	
1	heavy cloth	canvas or heavy sheeting; expendable
1	cheesecloth	one foot square
2–15	wool squares	about one foot square
2–15	silk squares	about one foot square
	string	
	thread	
	paper clips	
	pins	
	screw eyes	
	tacks	
	nails	assorted sizes
	wire	copper or steel
6–24	rubber balloons	small
12	candles	large candles, such as plumber's candles
30	paper cups	
2–15	combs	rubber preferred
1	celluloid swan	bathtub toy
1	board	10″ by 4′ or 6′ approx.
1	board	2″ by 4″ by 8′ approx.
1	board	1″ by 3″ by 3′ approx.
1	board	1″ by 3″ by 6′ approx.
1	construction board	4′ by 8′ by ¼″; "Upson" or other inexpensive type
	white pine scraps	

NUMBER	ITEM	REMARKS
	sugar	
	table salt	
	baking soda	
	epsom salts	
	tea	
	cocoa	
	food-colouring tablets	
	plant "food"	soluble fertilizers for house plants
	red ink	
	indelible pencil	
	poster paints	
1 pkg.	corn seeds	
1 pkg.	bean seeds	
	bird seed	for feeding station; other seeds may be used
4–24	narcissus bulbs	
1 lb.	corn meal	
	sand	clean; has many uses
	garden soil	for plants
	pebbles	for bulbs
	soft rock or brick	to be crushed into soil
	rock samples	preferably of local types
1	large flat rock	for crushing soft rock
1	orange	
1	banana	
12	lemons	for lemonade
2–15	blanched celery	
2–4	large carrots	
2–15	willow twigs	live; other types can be used
	cactus plants	
	aquarium plants	
	slips of house plants	coleus, geranium, philodendron, wandering Jew
1	small turtle	local species preferred

General References for the Teacher

Audubon Nature Bulletins. Prepared and published by the National Audubon Society, New York. 4 pages each.

These bulletins contain background information on the things of the natural environment. List sent by the Society on request.

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These leaflets contain background information and suggestions for teaching nearly every science topic. Consult the list of titles.

Fieldbook of Natural History. E. Laurence Palmer. McGraw-Hill: Toronto, 1949.

Condensed information on a wide variety of plants, animals, rocks and minerals.

Golden Treasury of Natural History. Bertha Parker. Musson: Toronto, 1952.

Interesting background information for the teacher.

Handbook of Nature Study. Anna B. Comstock. Thomas Allen: Toronto, 1947 ed.

Excellent reference on common plants and animals together with teaching suggestions.

Man in Structure and Function. Fritz Kahn. McClelland and Stewart: Toronto, 1943.

A beautifully illustrated work on the human body written in a clear understandable style. There is an excellent chapter on alcohol, tobacco, and other stimulants.

Elementary School Science and How To Teach It. Glenn O. Blough and Albert J. Hugget. Macmillan of Canada, 1951.

Among the main headings are: The Earth and the Universe; Living Things; Matter and Energy; Conservation of Our Resources; Fire and Prevention; The Behaviour and Habits of Animals.

Nature Notebook. Robert Candy. Thomas Nelson: Toronto, 1953. 114 pages.

Detailed, accurate information about life in woods and streams and notes on outdoor crafts enrich a father-and-son field trip. Beautifully illustrated by the author.

Science for the Elementary-School Teacher. Gerald S. Craig. Ginn: Toronto, 1947.

Background information on a variety of science fields together with specific suggestions for teaching the material.

Making and Using Classroom Science Materials in the Elementary School. Glenn O. Blough and Marjorie H. Campbell. Macmillan Company of Canada, 1954. 229 pages.

A practical book with descriptions of appropriate activities including photographs and drawings and carefully prepared lists of source material.

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Encyclopaedia Britannica Films. General Films Limited, 18 Breadalbane Street, Toronto.

Federation of Ontario Naturalists, 187 Highbourne Road, Toronto.

Gateway Productions Incorporated. Canadian Film Institute, 142 Sparks Street, Ottawa.

National Film Board, 71 Bank Street, Ottawa.

Ontario Department of Education, Visual Education Branch, 244 College Street, Toronto.

Popular Science. Ryerson Film Service, 299 Queen Street West, Toronto.

Young America Films. General Films Limited, 18 Breadalbane Street, Toronto.

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Thomas Allen Limited, 266 King Street West, Toronto.

Ambassador Books Limited, 1149 King Street West, Toronto.

Blue Ribbon Books, 105 Bond Street, Toronto.

Brett-Macmillan, 25 Hollinger Road, Toronto.

Clarke, Irwin & Company Limited, 103 St. Clair Avenue West, Toronto.

The Copp Clark Publishing Company Limited, 517 Wellington Street West, Toronto.

Doubleday Publishers, 105 Bond Street, Toronto.

W. J. Gage and Company Limited, 82 Spadina Avenue, Toronto.

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Oxford University Press, 480 University Avenue, Toronto.

Random House of Canada Limited, 1149 King Street, West, Toronto.

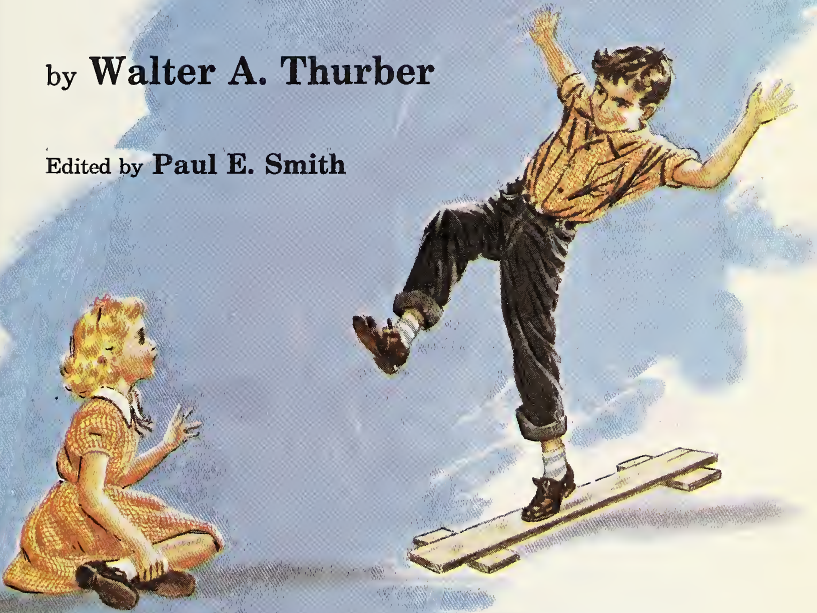
S. J. Reginald Saunders and Company Limited, 266 King Street West, Toronto.

The John C. Winston Company Limited, 130 Evans Avenue, Toronto.

EXPLORING SCIENCE *Four*

by **Walter A. Thurber**

Edited by **Paul E. Smith**



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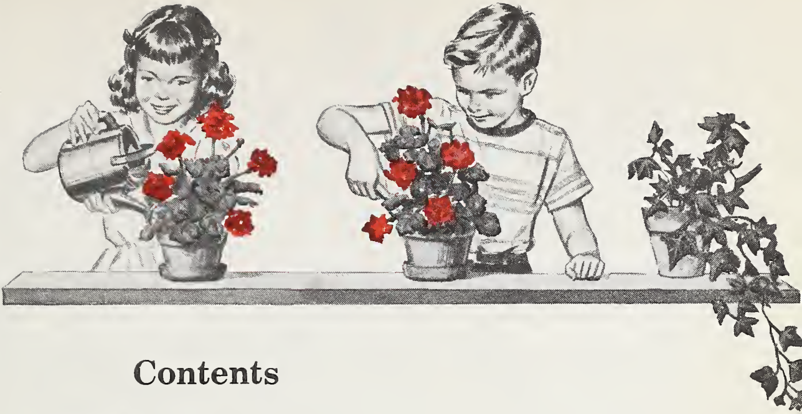

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Illustrated by

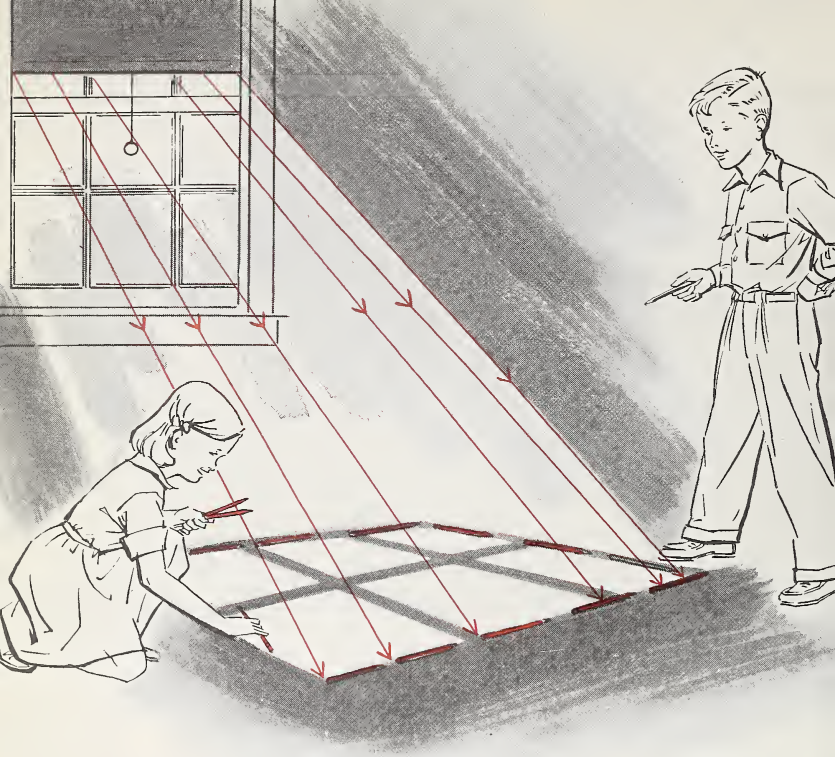
Albert and Violet Jousset
Cheslie D'Andrea
Robert Candy
Hugh Spencer

Night Comes

When Night Comes

There are many things for you to study when night comes. You can see things in the sky that you cannot see in the daytime. You can see animals that hide during the day and move about at night. Some plants close up their flowers and fold their leaves at night.

What things have you seen outdoors at night? What lights have you seen? What games do you play outdoors at night?



The Sun Moves

During the day you can see that the sun appears to move across the sky. Indoors you can put pencils around the edges of a spot of sunlight on the floor. In a few minutes you will see that the spot of sunlight has moved.

Outdoors you can mark the end of a shadow. In a few minutes you will see that the shadow has moved. In late afternoon the shadows move very fast. Do they grow longer or shorter in the afternoon?

Evening Shadows

Look at the sun going down some evening. You will see that it needs only a few minutes to move out of sight.

Watch the shadows of trees, buildings, and people as the sun goes down. The shadows grow longer and longer.

Hills make shadows too. Watch the shadows of hills grow longer.

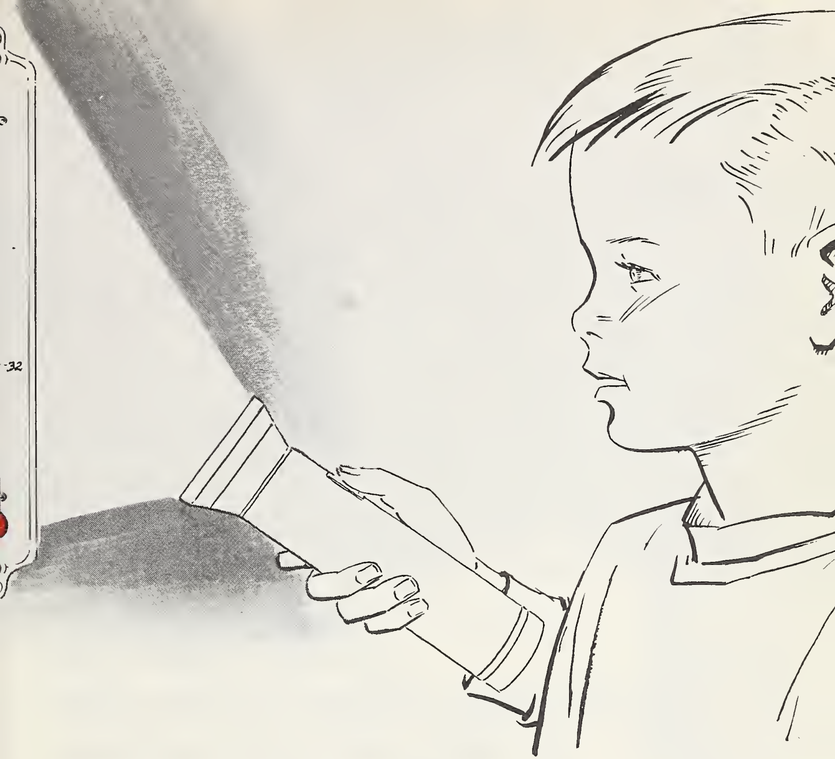
At last the shadows of the hills will reach you. Then you will not see the sun and things will become darker.

You may see the sun shining on tall trees and buildings for a short time. You may see the sun shining on hills behind you a little longer. And you may see the sun shining on clouds after everything else is in shadow.

Nightfall

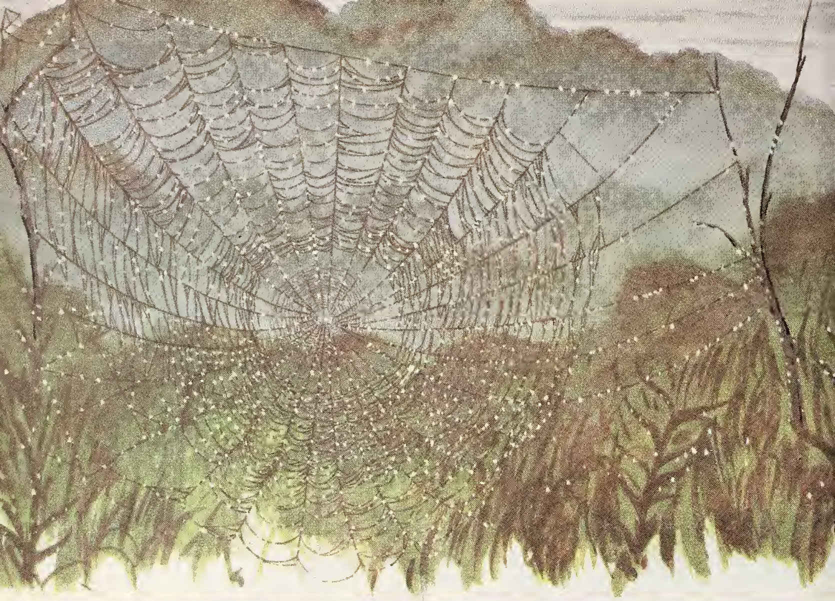
For a short time after the sun goes down, some of its light is reflected to us from clouds and from dust in the air. We call this kind of light "twilight." Find out how long twilight lasts some evening.

When everything is in shadow, night has come. What light do we have then? Is there enough light to see things outdoors? Is there enough light to tell what colours things have?



Usually we feel cooler when the evening shadows come. The sun gave us heat all day, but we begin to lose some of this heat as soon as we are in shadow.

Remember to look at a thermometer some clear afternoon, and then look at it again in the evening to see what happens.



On clear nights we often find little drops of water on spider webs and on plants. What do we usually call these drops of water?

Some of these drops of water may come from the leaves of the plants. But most of the drops condense from water vapour in the air. What does temperature have to do with these drops of water?

If the night were very cold, might we find frost instead of drops of water?

There are many animals that look for food at night. Owls hunt mice and other small animals. Bats catch insects flying through the air. Moths drink the sweet juice in flowers. Skunks hunt for mice and insects, and they eat berries and other small fruits. Rabbits do most of their feeding after dark.

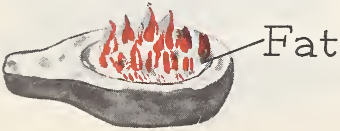
What are some other animals that feed at night? What do they eat?

Have you heard owls call at night? Have you heard crickets chirp? What other animals have you heard at night?

Light for Nighttime

The first light man ever made must have been a campfire. Then he may have learned to carry torches of burning wood.

We have found old stone lamps in caves. We think people burned fat in these lamps so they could have light at night.

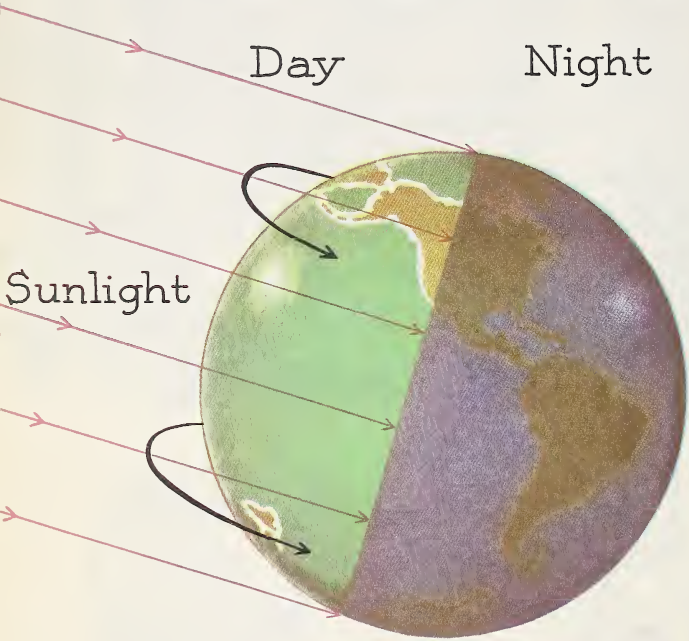


People invented the candle long ago. We do not know how it was discovered. Read about the ways candles are made. Perhaps you can make some too. Tell about the ways candles are used today.

What other kinds of light has man used? What kinds do we use today? Read about the ways these different kinds of light were discovered.

What Makes Day and Night?

People have always wondered where the sun goes after it goes down in the west. And they have wondered how it went back to the east to rise there in the morning.

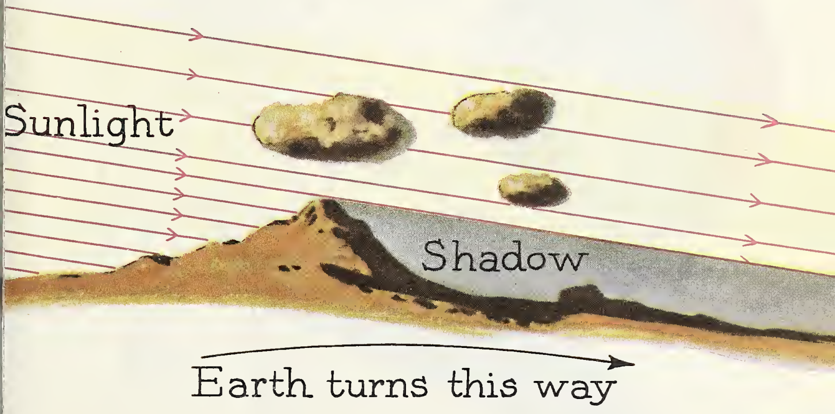


We believe today that the earth is shaped like a ball. The side that is toward the sun is in daylight. The side that is in the shadow has darkness.

We believe also that the earth keeps turning around. As the earth turns, we are in the sunlight part of the time and in the shadow part of the time. We believe that is the reason why we have day, then night, and then day again.

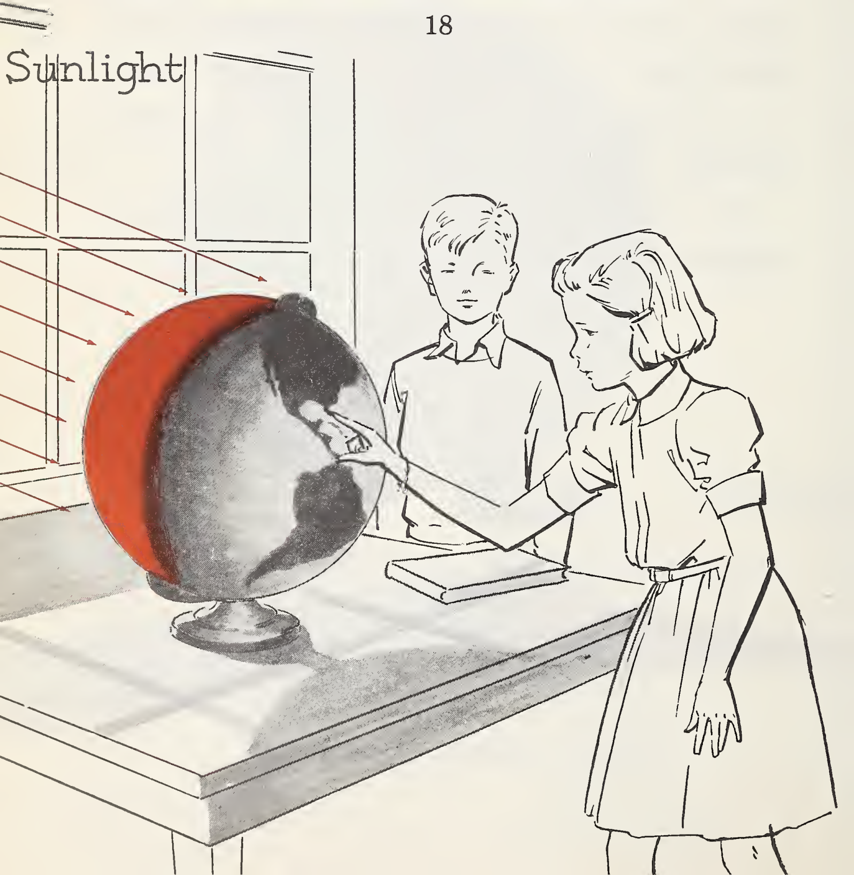
The picture below may help you understand what happens when the sun goes down. Can you see why the shadows of the hills grow longer? Can you see why there is sunlight on the clouds after the earth beneath is in shadow?

Can you make a drawing to show what happens at sunrise?



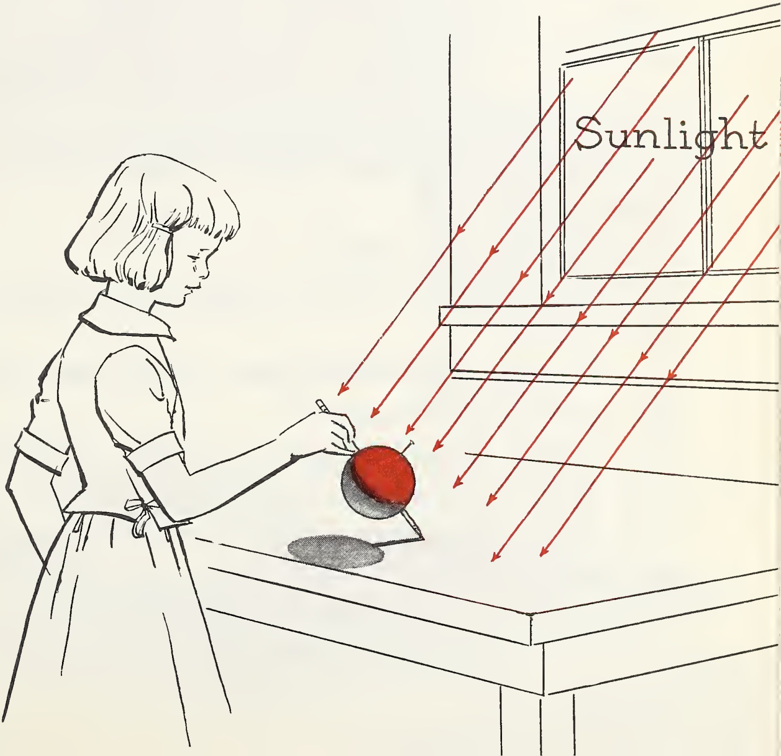
Set a globe in a sunny window. Find the place where you live. Watch this place as you turn the globe from right to left.

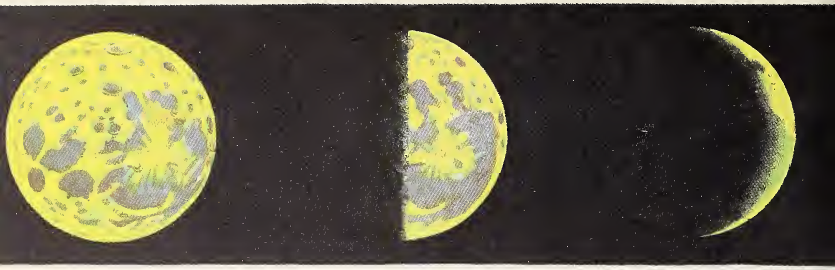
When the place where you live moves into the shadow it is night there. When it moves into the sun it is daytime. Turn the globe until the sun is over the place where you live, as it would be at noon.



Push a sharp pencil through an orange. Stick a pin in one side of the orange. Take the orange to a sunny window. Turn the orange around. Watch the shadow of the pin.

What is the shadow like when the sun is overhead? What happens to the shadow when the orange is turned farther? Do these shadows change like the shadows you see outdoors?





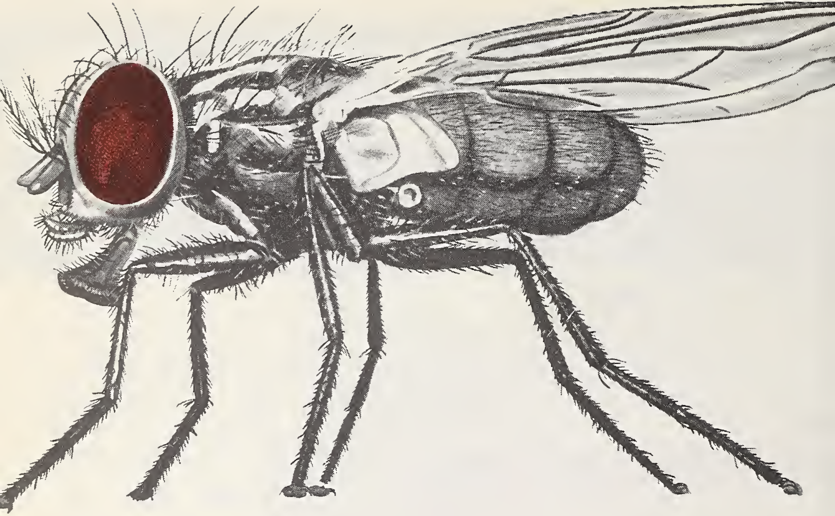
The moon has day and night, too. In the picture at the left, the side of the moon toward us is in the sunlight. It is night on the side away from us.

Look at the other two pictures of the moon. Where is it day and where is it night in each one?

---

1. Why do shadows grow longer in the afternoon?
2. What is twilight?
3. What do we think is the cause of day and night?
4. During nighttime here, what part of the world has daytime?
5. What things happen as night comes?
6. What animals hunt food at night?
7. What are some different kinds of light we use at night?

Insects That Carry Disease

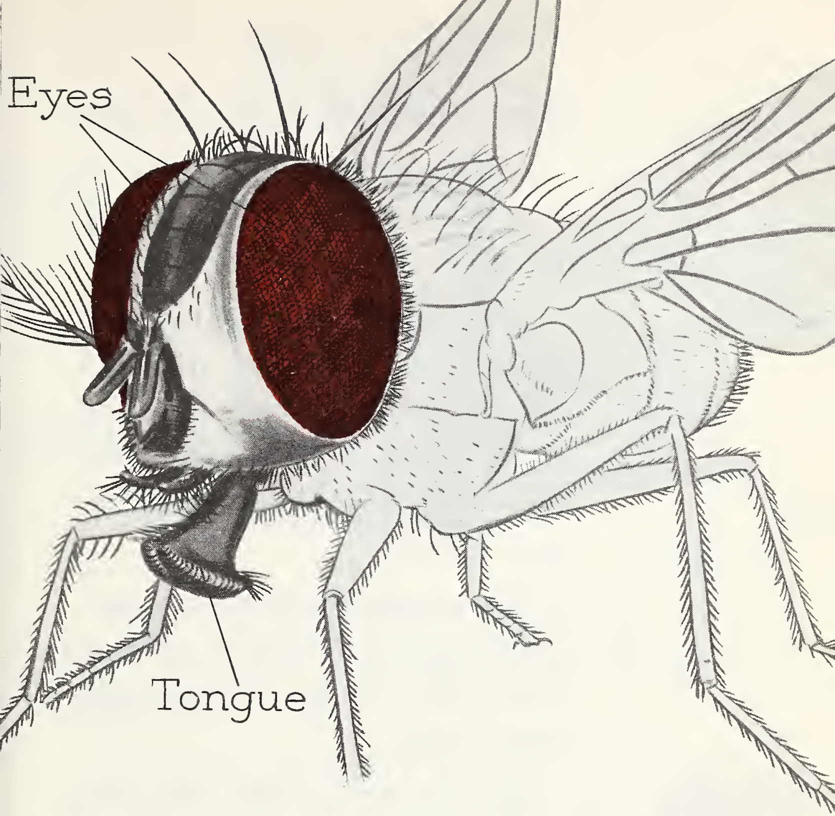


Houseflies Carry Disease

The most dangerous of all insects are the houseflies. Houseflies live in dirty places and can carry some of the dirt to your food.

Many kinds of **bacteria** live in this dirt. Bacteria are tiny living things that cannot be seen without a microscope. Some of the bacteria in the dirt can give you diseases.

Look at a fly with a hand lens. You can see that the fly is covered with many tiny hairs. Bits of dirt stick to these hairs.



A housefly wets its food with its tongue as it eats. Sometimes the fly has been eating food that is filled with disease bacteria. Then the fly may leave the disease bacteria on our food.

Watch a housefly eating. Watch it use its tongue as it wets its food.

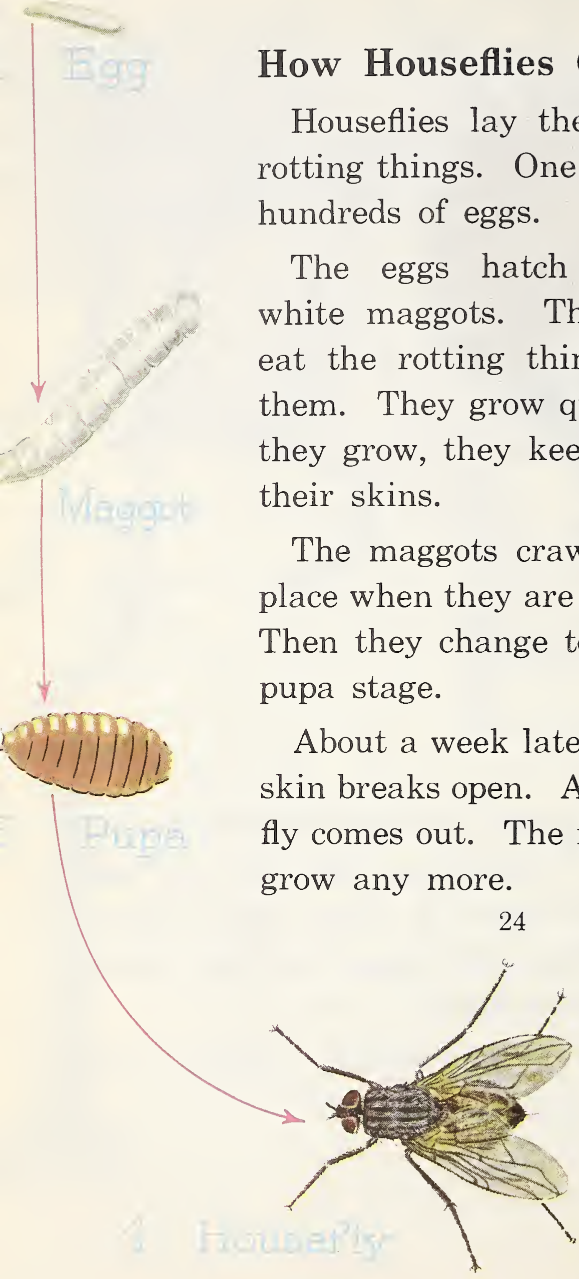
How Houseflies Grow Up

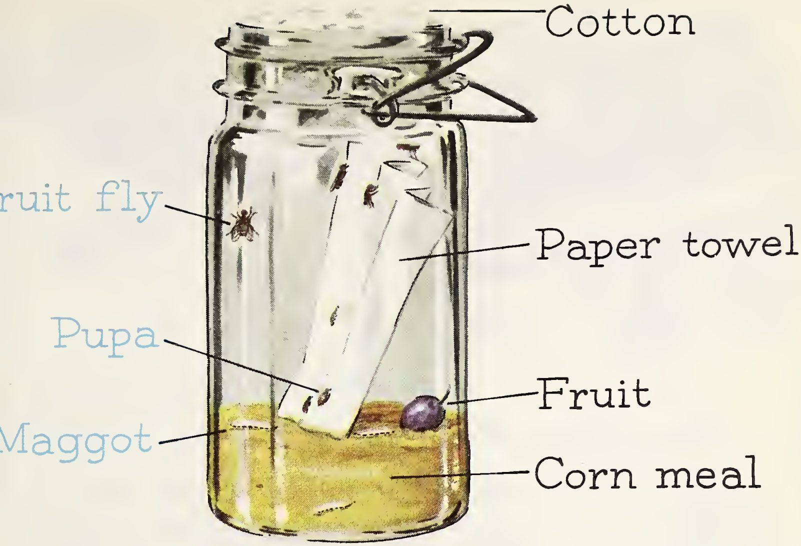
Houseflies lay their eggs in rotting things. One fly can lay hundreds of eggs.

The eggs hatch into tiny white maggots. The maggots eat the rotting things around them. They grow quickly. As they grow, they keep shedding their skins.

The maggots crawl to a dry place when they are full grown. Then they change to the quiet pupa stage.

About a week later, the pupa skin breaks open. A full-grown fly comes out. The fly does not grow any more.

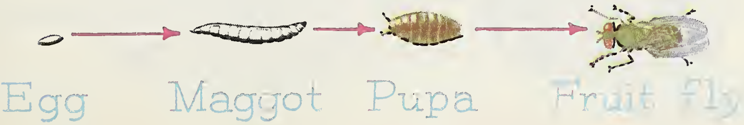




There are many other kinds of flies. One kind that lives in rotting fruit is called the "fruit fly."

You can raise fruit flies easily. Boil some corn meal for five minutes and pour it into a clean jar. Drop in a grape or a piece of banana. Fold a piece of paper towel and put that in, too.

Leave the jar near some spoiling fruit until six or eight flies are inside. Then put cotton in the top. Leave the jar in a warm room and watch it.

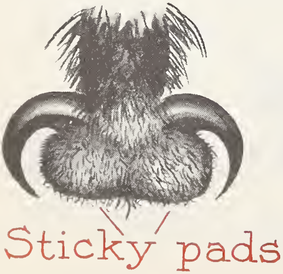


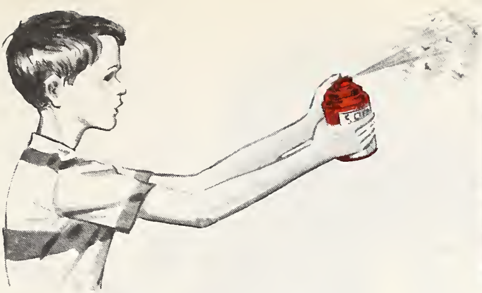
How Flies Walk on Walls

Flies have two little claws at the end of each foot. These claws help the fly climb up rough things.

Between the claws are two little pads covered with sticky hairs. These sticky pads help the fly climb on smooth things. A fly can climb a window pane easily, and it can even walk upside down on the ceiling. The sticky pads hold the fly to the ceiling. Watch a fly walk on a window pane or on the ceiling.

How do you think the sticky pads help the fly carry disease bacteria?



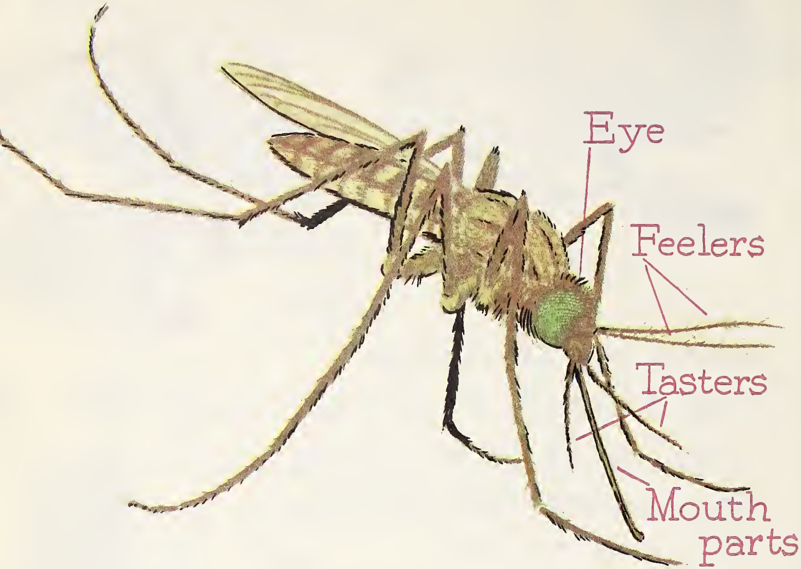


Protecting Ourselves from Flies

We should do everything we can to keep flies from our homes and our food.

We should clean up the things that make flies want to come to our homes. We should keep garbage in covered pails. What else can we do?

What can we do to the flies that do get into our homes?

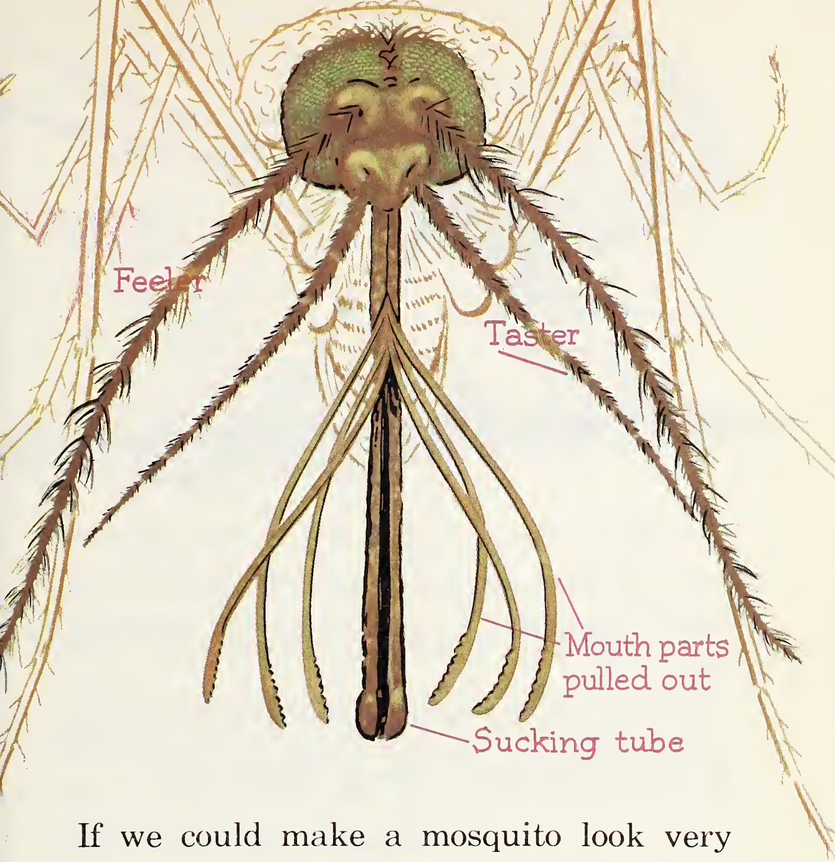


How Mosquitoes Eat

Mosquitoes have long, sharp mouth parts. They can make holes in plants and suck the juices.

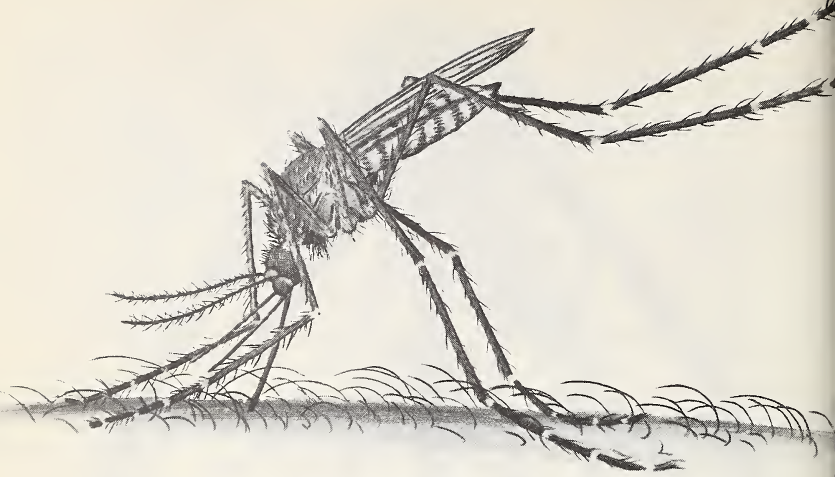
Female mosquitoes also make holes in the skin of animals and suck blood. Female mosquitoes are the ones that lay the eggs.

Male mosquitoes do not suck blood.



If we could make a mosquito look very large, we would see how it is able to make holes in plants or in the skin of animals. Some of the mouth parts are like tiny knives and saws.

There is a tube around the sharp parts. The mosquito drinks through the tube much as you drink through a soda straw.

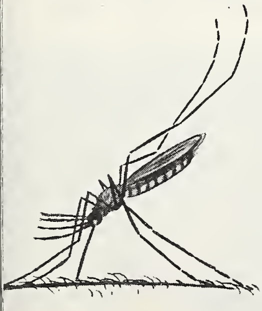


In the picture at the top of the page, we see a female mosquito getting ready to eat. She is beginning to make a hole in someone's skin.

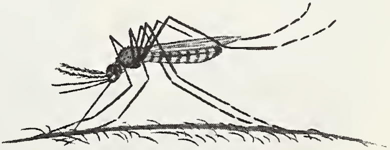
In the picture at the bottom, the mosquito is sucking blood. She is nearly full.

How Mosquitoes Carry Disease

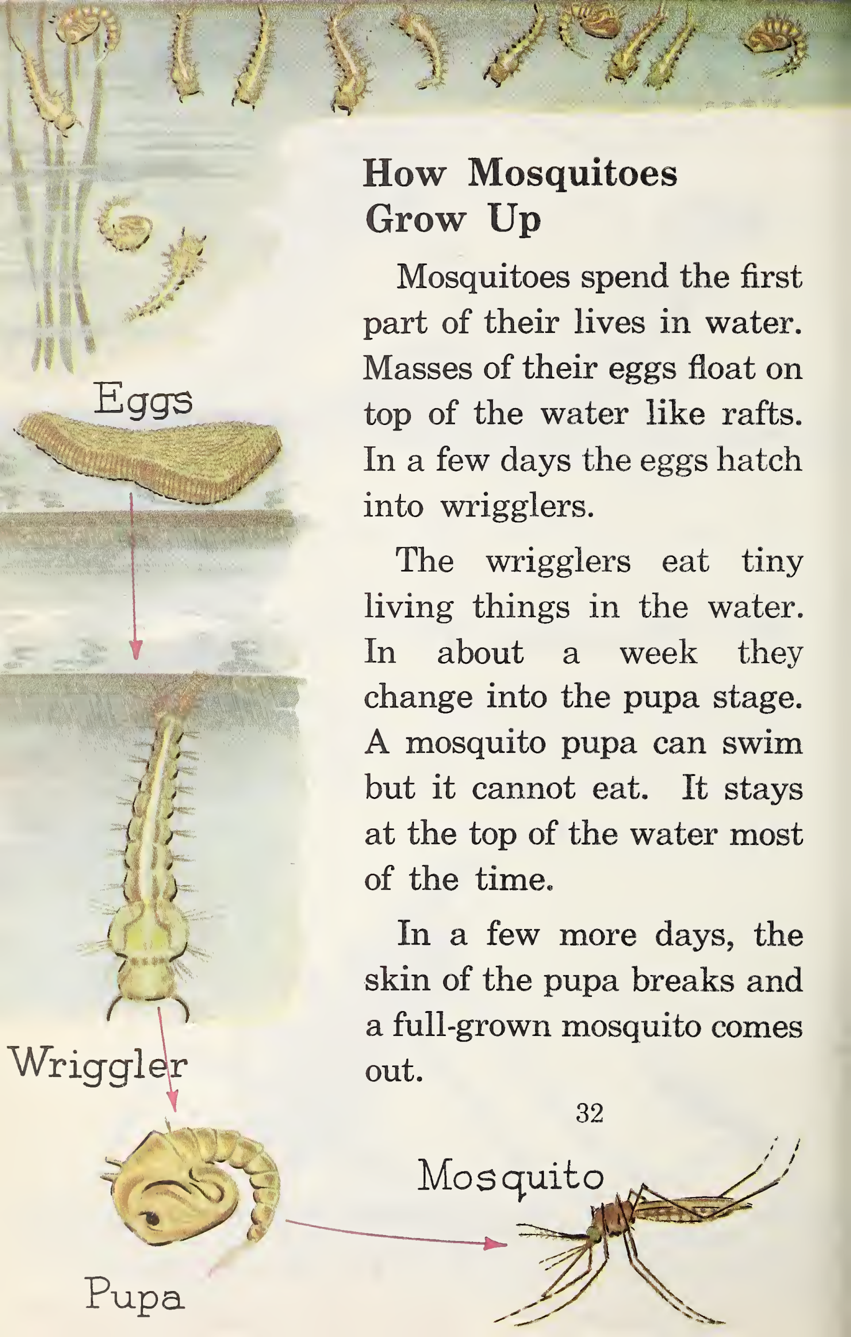
Some kinds of mosquitoes carry diseases. They may take blood from sick people. Then they may bite people who are well and give them the same disease.



his mosquito
n carry disease.



This mosquito
does not carry disease.



How Mosquitoes Grow Up

Mosquitoes spend the first part of their lives in water. Masses of their eggs float on top of the water like rafts. In a few days the eggs hatch into wrigglers.

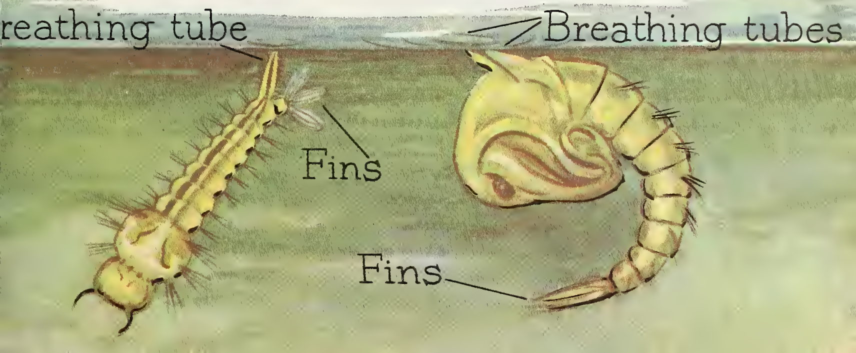
The wrigglers eat tiny living things in the water. In about a week they change into the pupa stage. A mosquito pupa can swim but it cannot eat. It stays at the top of the water most of the time.

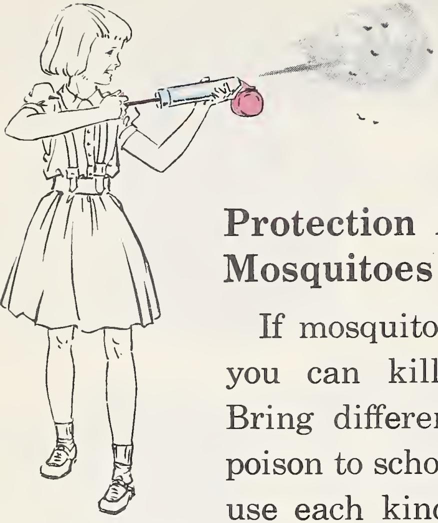
In a few more days, the skin of the pupa breaks and a full-grown mosquito comes out.

Find some mosquito wrigglers and put them in a glass of water. Watch them and you can see why they are called "wrigglers."

Watch one wriggler. You will see that it comes to the top often. It comes to the top for air.

Put some wrigglers in a glass jar and tie a piece of cloth over the top. Use water from the pool where you found the wrigglers. Watch the wrigglers for a few days. Some may change into the pupa stage and some of these may later become mosquitoes.





Protection Against Mosquitoes

If mosquitoes get in your home, you can kill them with poison. Bring different kinds of mosquito poison to school and find out how to use each kind.

How can you keep mosquitoes from getting into your home?

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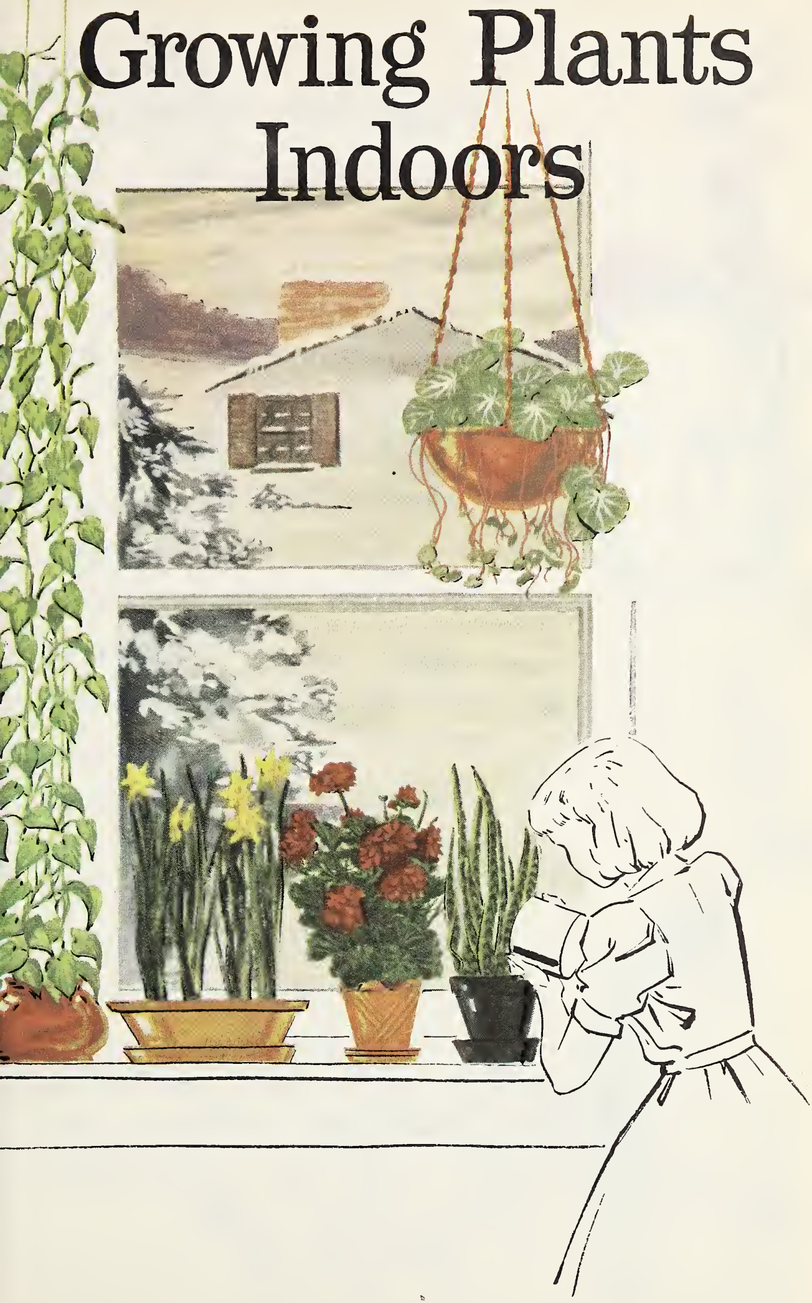
1. Tell the life story of a housefly and of a mosquito.
2. What do houseflies and mosquitoes eat?
3. How many legs and wings do houseflies and mosquitoes have?
4. Tell about the mouth parts of houseflies and mosquitoes.
5. How can houseflies walk upside down on a ceiling?
6. Tell why houseflies and mosquitoes may be harmful.

Growing Plants Indoors



Plants from Cuttings

Ask someone for a few branches of some coleus plants. Put the stems of some of these branches in glass jars of water. Set the jars on a window sill or on a table near a window.

Look at the stems every day. Soon you will see some little roots begin to grow.

How many days did it take for the roots to start growing?

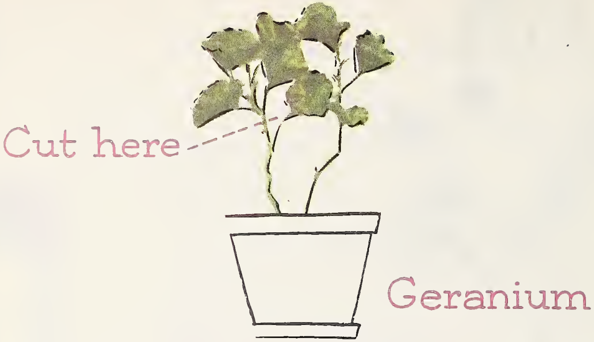
Wandering Jew

Put the stems of some other plants in water. Will they grow roots? Two kinds you may try are shown on this page.

When your plants have many roots, plant them in pots of good soil. Keep the soil moist.

Take some of your plants home. Give some to teachers who have no plants in their rooms. Keep some for your own schoolroom.

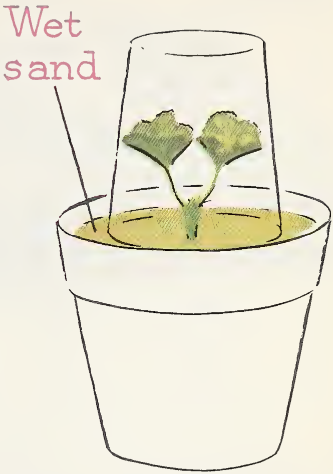
Philodendron



Geraniums from Cuttings

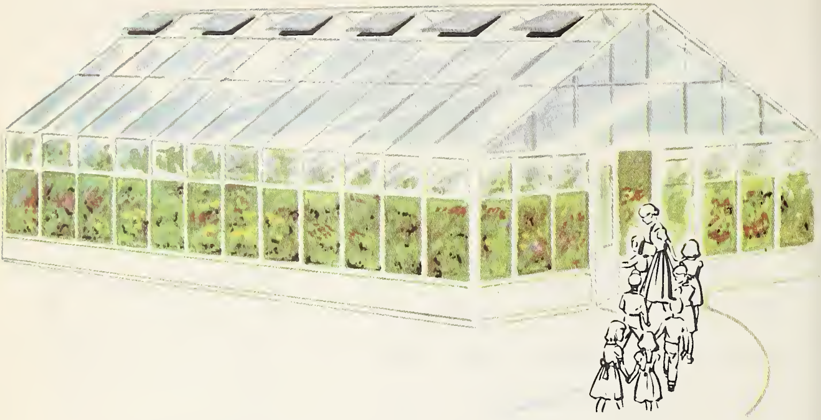
Cuttings from geraniums will grow roots in wet sand.

Cut off the end of a geranium stem. Take off all but one or two small leaves.



Put the cutting in a pot of wet sand. Put a drinking glass over the top. Keep the sand wet.

In about two weeks, there will be roots growing from the cutting. Dig up the cutting and plant it in a pot of good soil. Put the plant in a sunny window. Keep the soil moist but not wet.



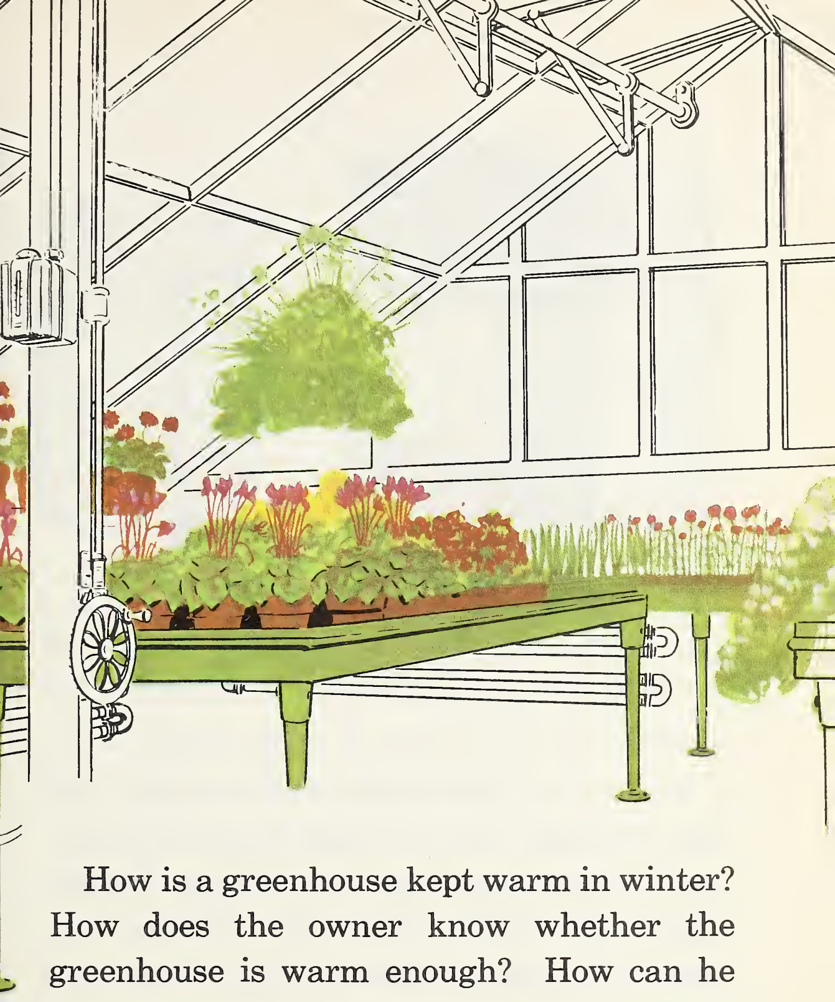
Greenhouses

Most plants will not grow outdoors during cold weather. Plants need warmth to grow.

We can keep such plants in a greenhouse. The plants will grow and many of them will have flowers.

The air inside a greenhouse is warm. Sunlight for the plants comes in through the glass roof and sides.

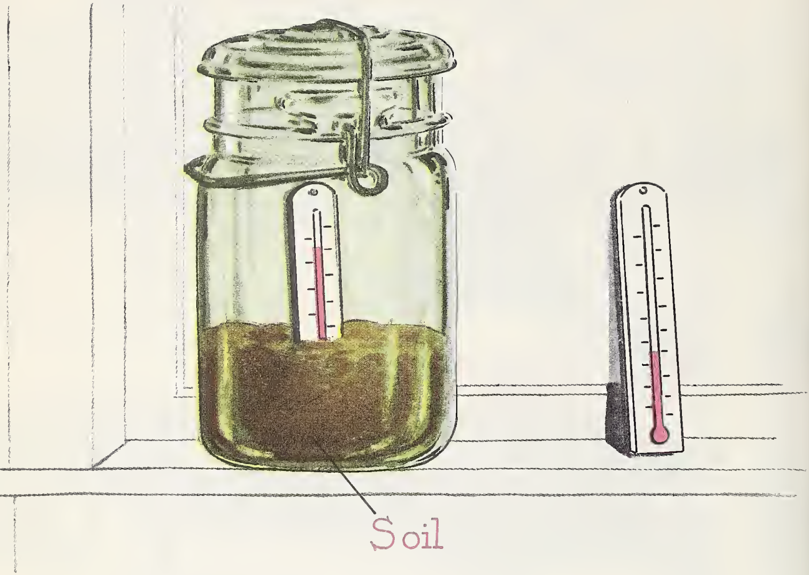
Visit a greenhouse. You will see men planting seeds, bulbs, and cuttings. They sell the plants and the flowers to people who like to have plants and flowers in their homes in winter.



How is a greenhouse kept warm in winter? How does the owner know whether the greenhouse is warm enough? How can he cool the greenhouse if it becomes too warm?

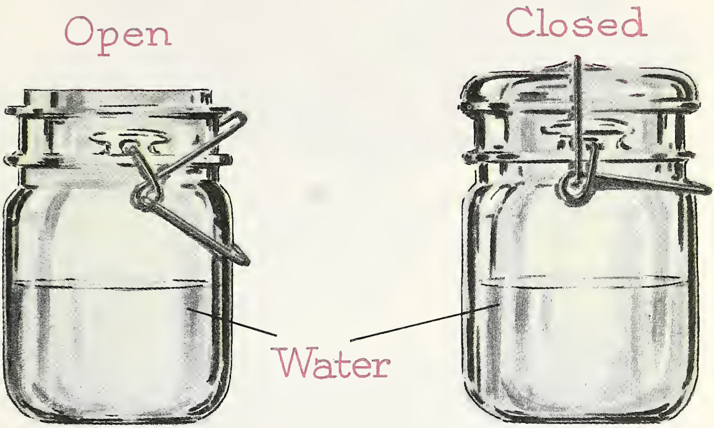
How are the plants watered?

Tell why the air in greenhouses is often damp.



Put two inches of soil in a fruit jar. Set the jar outdoors in sunlight on a cool day. Does the temperature in the jar become higher or lower than the temperature outside the jar, or does it stay the same?

What does sunlight do to the soil and the air inside the jar? Now can you explain why a greenhouse becomes so warm on a sunny day?



Find two fruit jars that are alike. Put the same amount of water in each jar. Close one jar. Leave the other jar open.

Put both jars in a warm place for two or three days. What happens?

Water evaporates in both jars, but the water vapour cannot get out of the closed jar. Soon the air in this jar cannot hold more water vapour. Then the water in the jar stops evaporating.

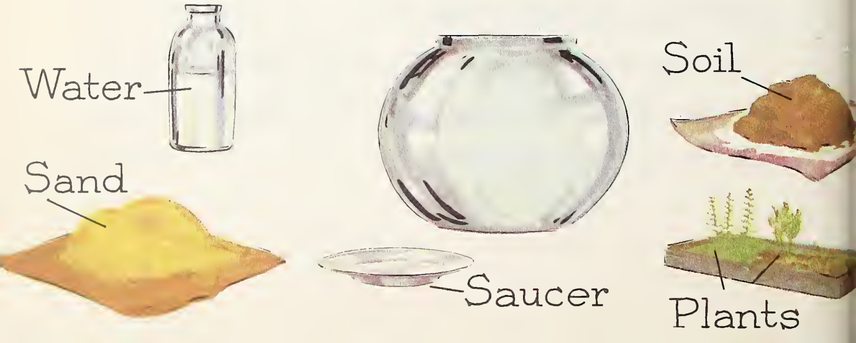
Water vapour can get out of the open jar. The water in this jar keeps on evaporating. All of it may evaporate.

Making a Winter Garden

Most wild plants will not live in our homes in winter. The air in our homes is too dry.

We can raise some of these wild plants by putting them in a glass bowl that has a cover. A saucer makes a good cover. The air in the covered bowl will stay moist.

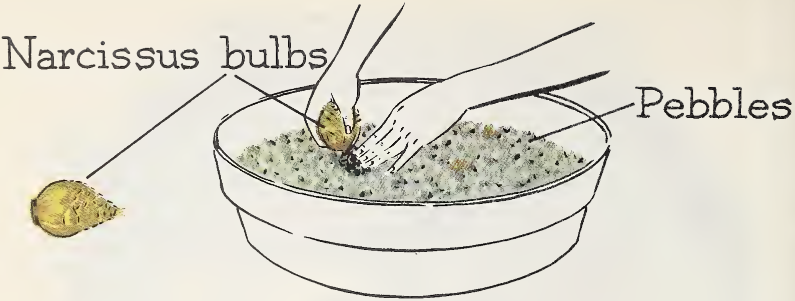
The plants need some of the same soil they grew in. Put in some sand first, then put in the soil, and then put in the plants. Water the plants a little and put the cover on. You do not need to water the plants again. Can you tell why?



Soon the inside of the glass bowl will be covered with drops of water. Where does this water come from? How did the water get into the air?

Watch the drops on the sides of the bowl. What happens to them?

Set the bowl in sunlight. Which side has the most drops on it? Is this side the cool or the warm side? Can you tell why there are more drops on this side?

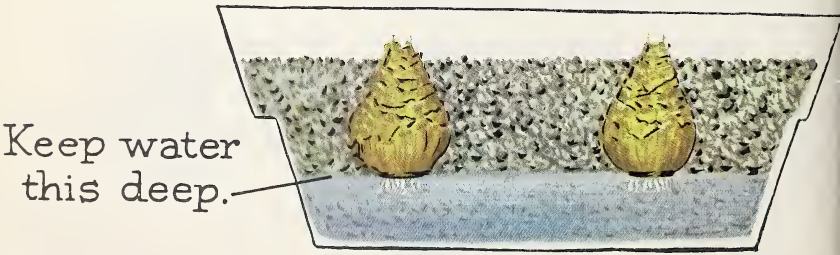


Plants From Bulbs

Bulbs will give you some nice flowers for winter.

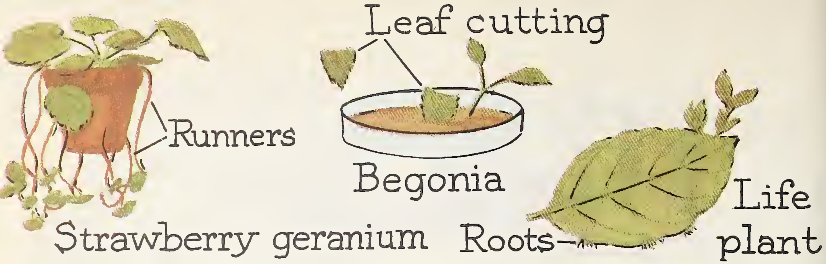
Put small pebbles in a pan that is three or four inches deep. Set some narcissus bulbs in the pebbles. The tops of the bulbs should not be covered.

Pour enough water in the pan to touch the bottoms of the bulbs. Add more water as some of the water evaporates into the air.


Keep water this deep.

Keep the bulbs in a cool place until the buds have grown. A north window is a good place for them.

Watch the buds. When they are ready to open, you may move the plants to a sunny window.



Other Ways of Starting Plants

Some plants send out runners. New plants grow at the ends of the runners. These new plants will grow if you put them in soil.

Some plants will grow from bits of leaves put in the soil. Try to raise plants this way.

---

1. What are some ways we can start plants without seeds?
2. What parts do plants have above ground? What parts do they have below ground?
3. How is a greenhouse kept warm?
4. Why do most plants grow better in a greenhouse than in our homes?
5. Why is the air moist in a winter garden such as you have just made?

Things That Dissolve

Making Things Dissolve

Some boys and girls made lemonade. They squeezed a dozen lemons and put the juice in four quarts of water. They did not like it. Do you know why?

Then they put some sugar in each cup and stirred it. Soon they could not see the sugar. It seemed to be gone.

But the lemonade tasted better. The sugar was really there. It had **dissolved** in water.

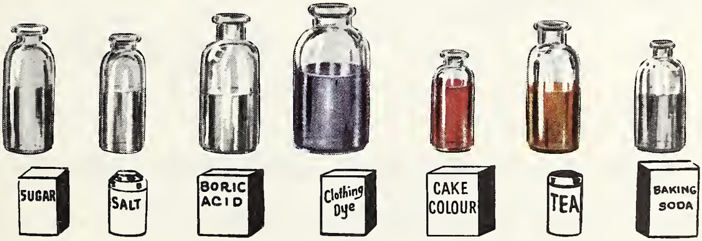
Stir a little sugar in a glass of water and watch it dissolve. Try some clean sand. Does it dissolve?

Try coal, chalk, wood, salt, baking soda, and many other things. Which ones dissolve?

It is fun to dissolve things that are coloured. Buy some cake-colouring tablets. Break off little pieces and dissolve them.

Some kinds of pencils dissolve in water. You can make ink of them.

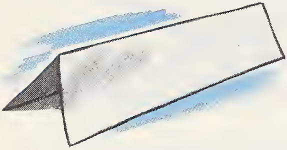
Collect many things that dissolve in water. Dissolve them and put them in bottles. Find out how we use these things.



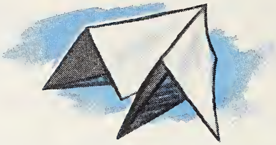
THINGS THAT DISSOLVE

Making and Using a Filter

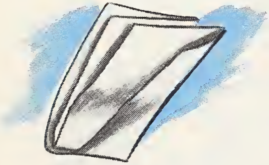
Some things will go through a **filter** and some will not. Will things dissolved in water go through a filter? Let's find out.



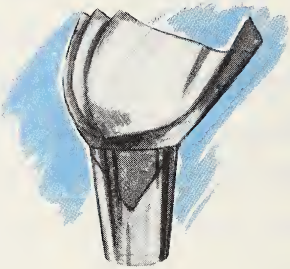
Fold a paper towel like this.



Fold it again like this.

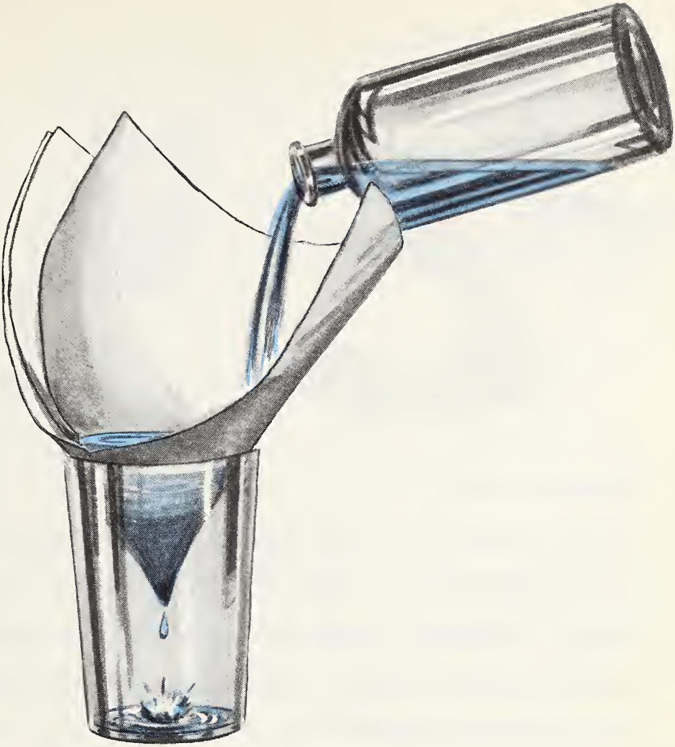


Open the paper towel like this.



Put it in a glass like this.

Your filter will look something like a funnel that does not have a hole.



Pour salt water in your filter. Taste the water that goes through. Is there salt in it?

Try sugar water. Will blue ink go through a filter? Will cake colouring?

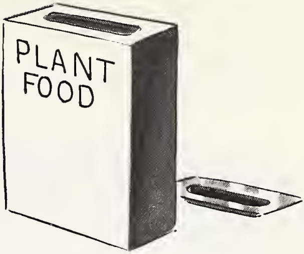
Will muddy water? Will cocoa?

Things that do not go through the filter are not dissolved in the water. They are just mixed with the water.

Secret Ink

Put a little water in a small dish. Dissolve as much baking soda as you can in the water. Write a secret message with the baking soda water. Use a new pen that has never touched ink.

To read the secret message, warm the paper very carefully over a candle flame. Be careful not to hold the paper too close to the flame or it may catch fire.



Helping House Plants

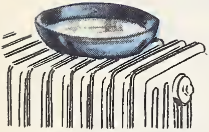
House plants need certain **minerals** to grow well. The plants sometimes use most of the minerals in the soil. You may put more minerals in the soil for the plants.

Buy a package of these minerals and dissolve them in water following the directions on the package. Water some house plants with these minerals.

Evaporating Salt Water

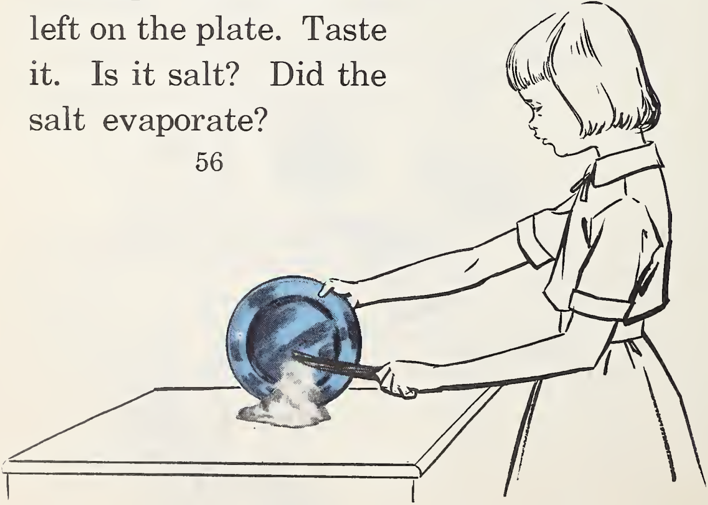
Dissolve as much salt as you can in a glass of water.

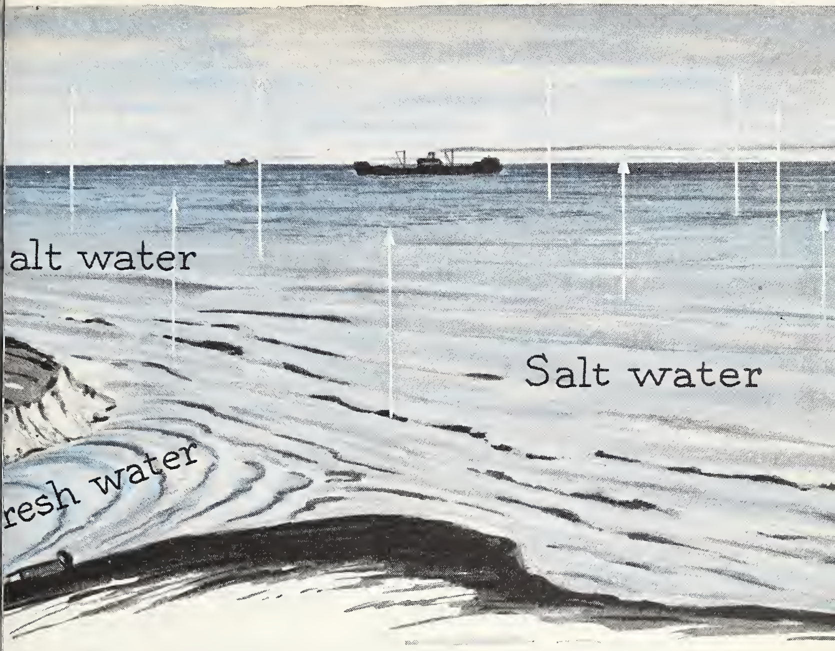
Pour a little of the salt water on a plate. Set this in a warm place.



Wait until all the water has evaporated.

Scrape out what is left on the plate. Taste it. Is it salt? Did the salt evaporate?





If you have ever been swimming in the ocean you have probably tasted the water.

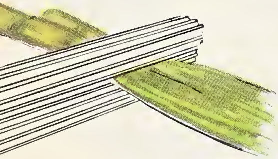
Ocean water tastes salty. Salt and many other minerals are dissolved in it. That is why ocean water is called salt water.

When ocean water evaporates, the minerals do not evaporate with it. They stay in the ocean. That is why the ocean is always salty.

Making Cane Sugar

Much of our sugar comes from the plants called sugar cane.

The plants are filled with a juice called **sap.** There is sugar dissolved in the sap.



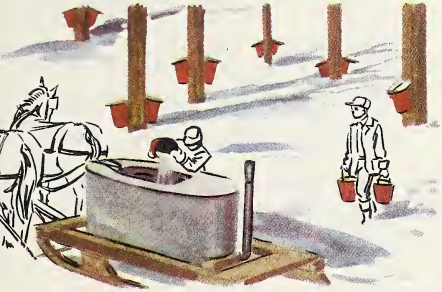
The sugar cane is cut and then pressed between heavy rollers. The rollers squeeze out the sweet sap.

The sap is then heated in big tanks. The water evaporates from the sap, and the sugar is left in the tank.

Making Maple Sugar

Maple sugar is made from the sweet sap of sugar maple trees.

Little holes are made in the trees in early spring. The sap drips out into pails.



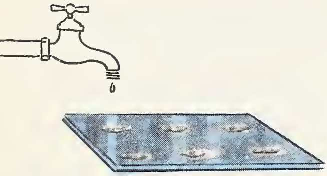
The sap is carried to the sugar-making house.

The water is evaporated from the sap. Maple sugar is left.

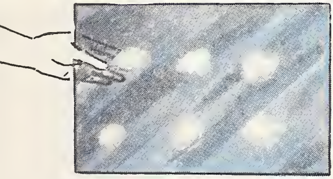
Minerals in Drinking Water

In some parts of the country, the drinking water has many minerals dissolved in it. Try this test on your drinking water.

Clean both sides of a piece of glass.

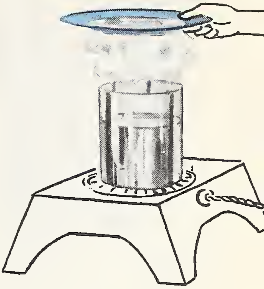


Put a few drops of drinking water on the glass. Wait until the water evaporates. How can you make it evaporate faster?



Is anything left on the glass? Where did it come from?

Water that has minerals dissolved in it is called "hard water." Is your drinking water hard?



Rain Water

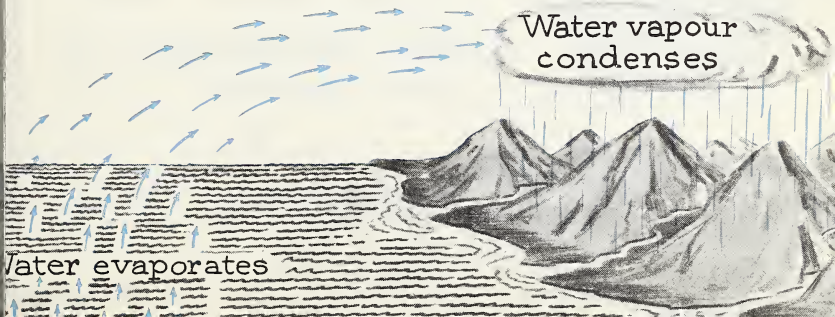
Boil some salt water. Hold a clean plate over the boiling water.

Soon there will be drops of water on the plate. Taste them. Are they salty?

Rain is made when water evaporates and condenses again. Some of the water in rivers and oceans changes into water vapour. Then some of the water vapour condenses into rain.

Dirt in rivers and salt in oceans do not evaporate. Rain water is clean. Almost nothing is dissolved in it.

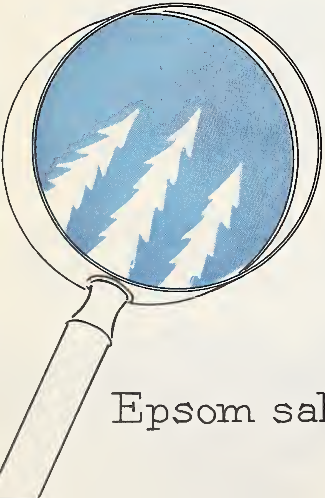
Test some rain water to see if there are minerals dissolved in it.

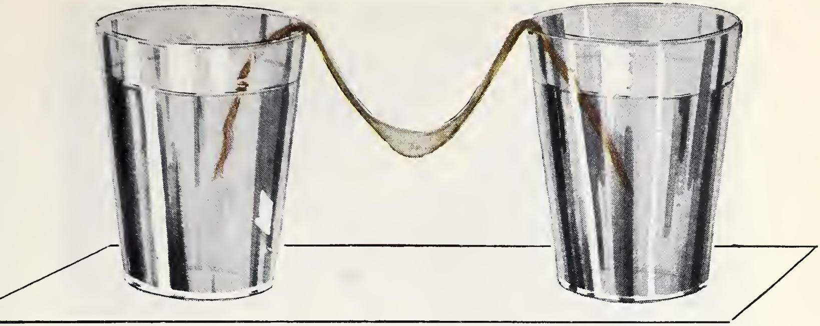


Crystals

Sometimes the minerals dissolved in water take certain shapes when the water evaporates. We call them **crystals.**

Add Epsom salts, a little at a time, to a glass of hot water until no more will dissolve. Dip a brush in the water and paint a piece of glass with it. Use a hand lens to watch the water evaporate.


Epsom salt crystals



Here is another way to make a crystal. Dissolve Epsom salts in two glasses of hot water. Wet a string and put one end in each glass of water as shown. In an hour or so, look at the string.

Perhaps you can find out about other kinds of crystals you can make. Look at these crystals with a hand lens. Each kind has its own shape.

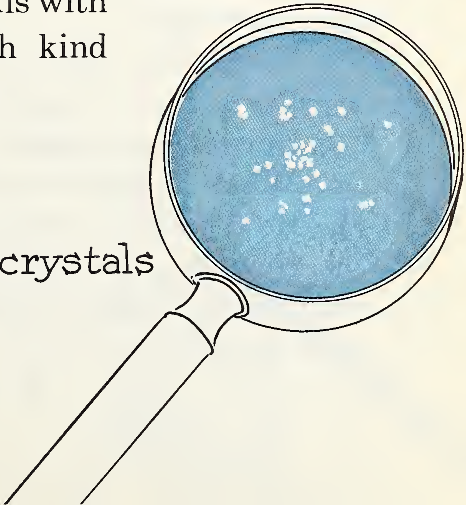
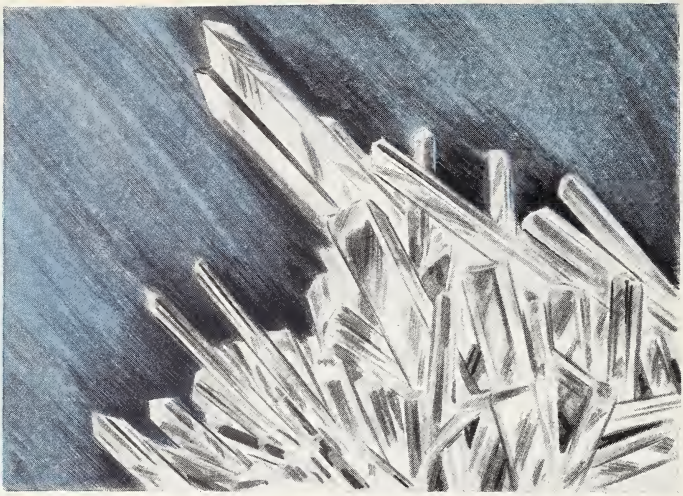


Table salt crystals

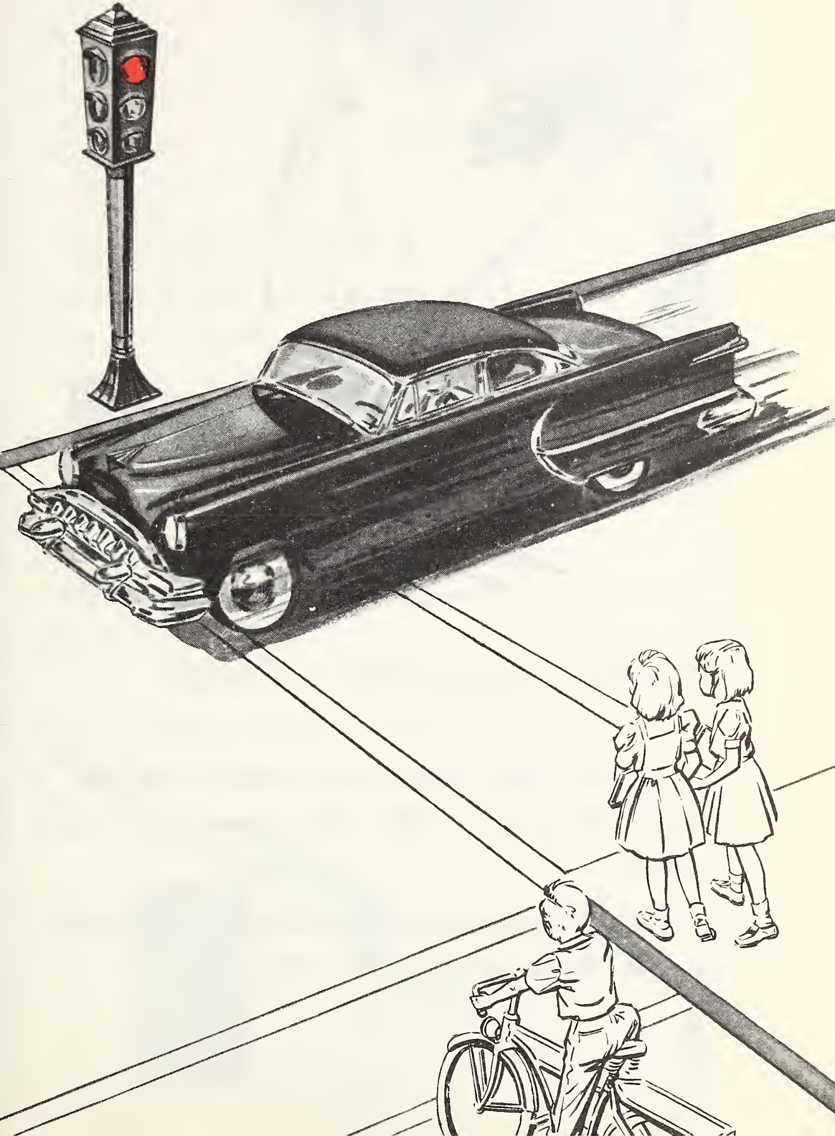


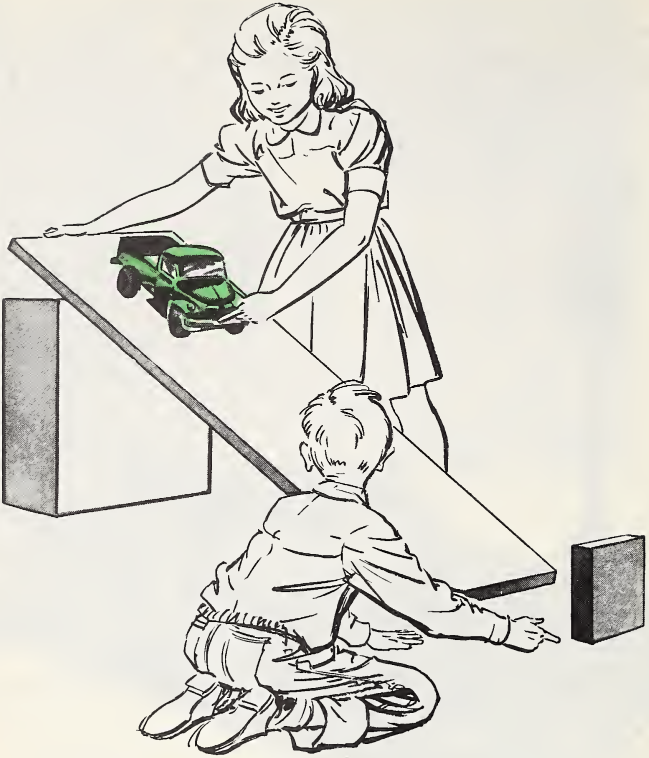
Sometimes people find crystals in rocks. Many crystals were made from minerals that were dissolved in water in the ground.

---

1. What are some things that dissolve well in water?
2. What are some things that do not dissolve well in water?
3. How is cane sugar made?
4. What is hard water?
5. How can you make crystals?
6. How can you tell whether something dissolves in water or whether it just mixes with water?

Stopping Safely

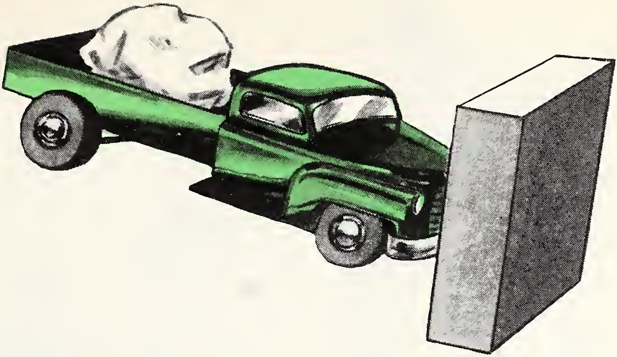




Moving Things Have Energy

Put a toy truck on a board as shown. Let the truck roll down the board and hit a block of wood. How far does the block move?

The moving truck has energy. The energy of the truck makes the block move.

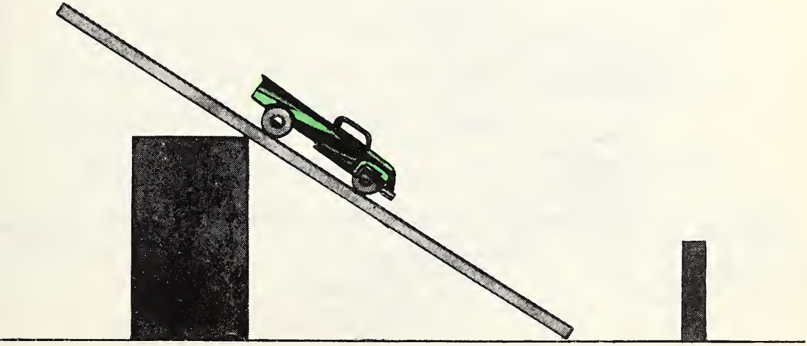


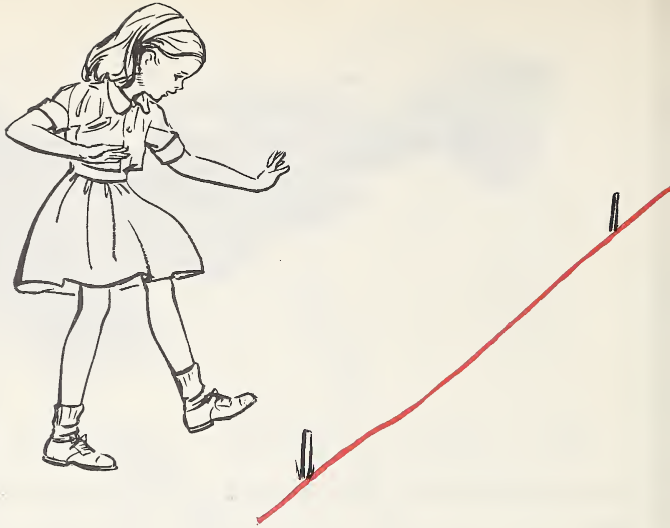
Put a stone in the toy truck. Let the truck roll down the board and hit the block. How far does the block move this time?

Tip the board more, so that the truck moves faster. How far does the block move?

How does more weight change the energy of the moving truck?

How does more speed change the energy of the truck?

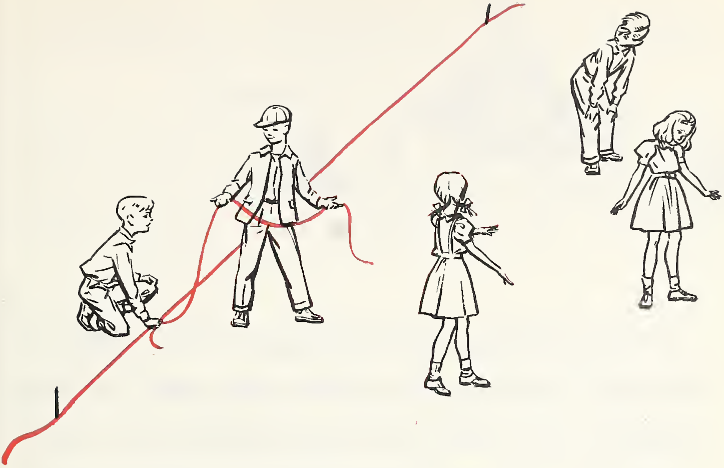




Stopping Distances

Lay a string on the ground between two stakes. Walk up to the string and try to stop on the line. Can you do it?

Now run up to the line as fast as you can and then try to stop. How far over the line did you go?



The distance between the place where you try to stop and the place you really stop is called the stopping distance.

The faster you move, the more energy you have and the harder it is to stop. You need a longer stopping distance when you move fast.

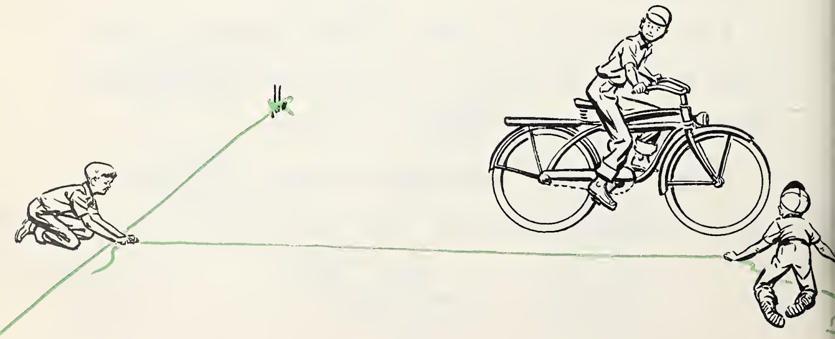
Let everyone in the class run up to the line as fast as he can. Measure the stopping distance of each one.

Why should everyone know how much his stopping distance is?

Ride a bicycle slowly across a line. When the front wheel is on the line, put on the brakes. How far do you go before you stop?

Ride up to the line as fast as you can go. Put on the brakes when the front wheel is on the line. How far do you go this time? Why do you go farther?

Why should every bicycle rider know about stopping distances?



Stopping Distances of Automobiles

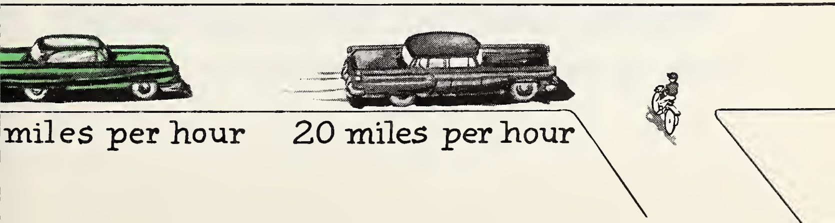
Speed	Distance
20 miles per hour	30 feet
40 miles per hour	120 feet

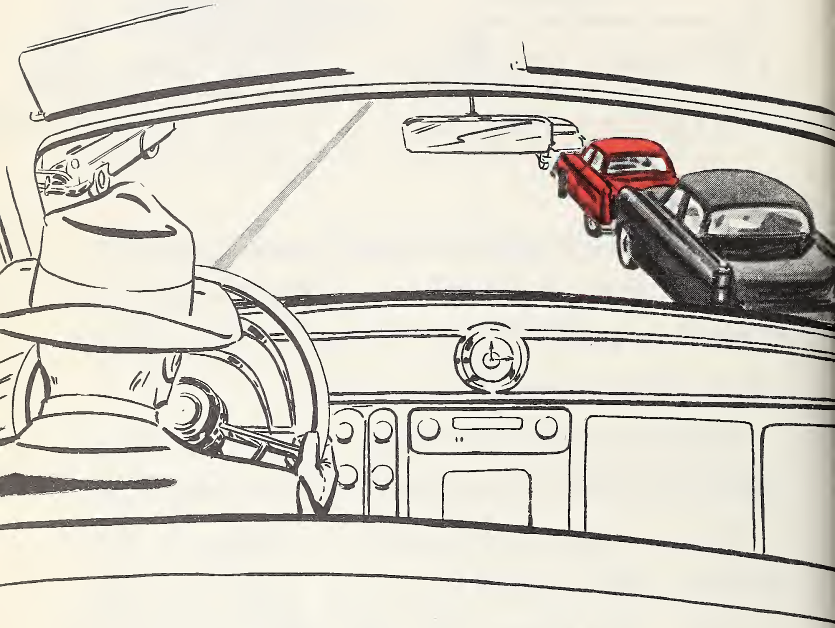
A car with good brakes needs about 30 feet to stop when it is going 20 miles an hour. It needs about 120 feet to stop when it is going 40 miles an hour.

Measure these distances on the side of a street so that you can see how long they are.

Look at the picture below. Suppose the boy on the bicycle rides out from the side street. The black car could stop in time if it were 30 feet away. How far away would the green car need to be?

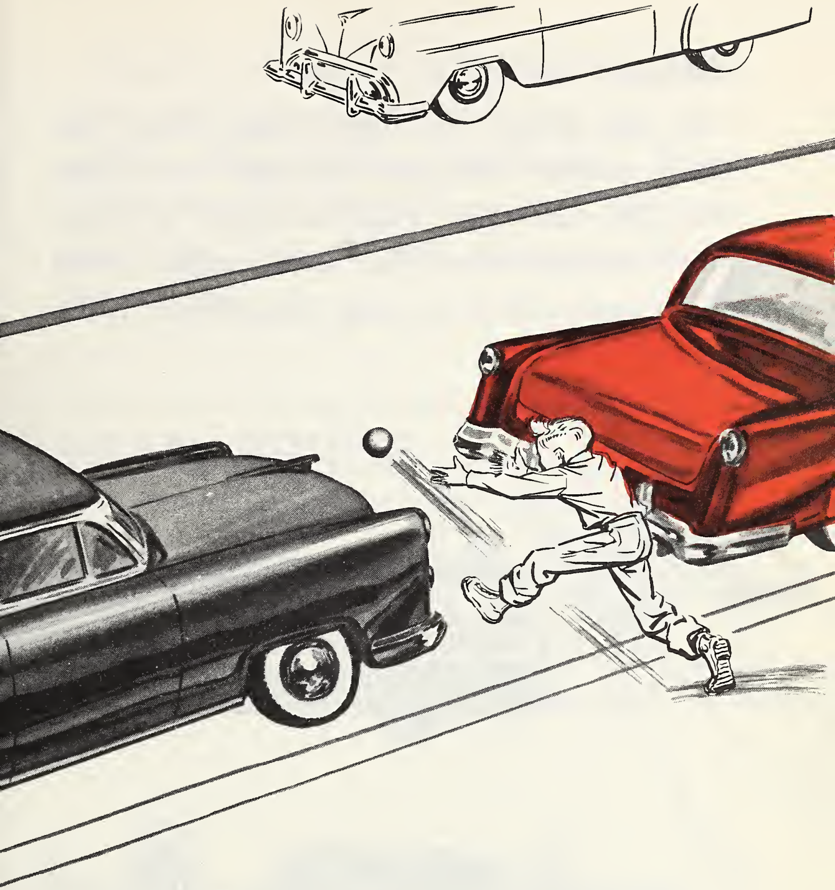
Why is it important to know about stopping distances?





This is what a driver may see as he drives along the street. Does everything seem safe?

What are some things that may happen? Look at the next page.

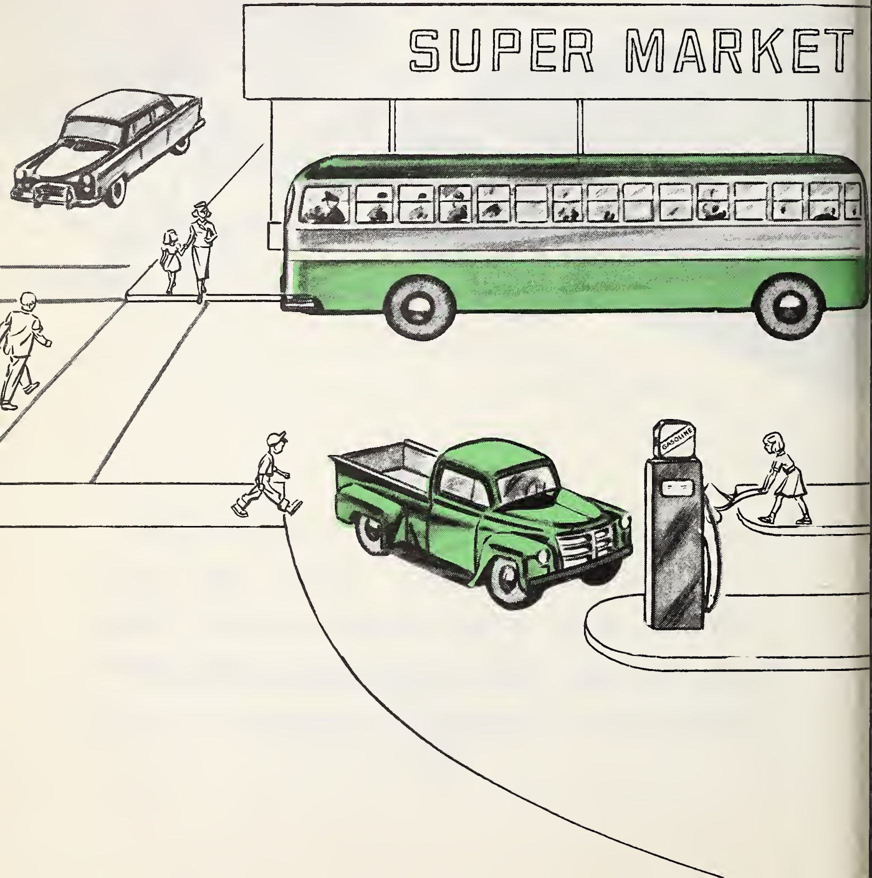


This is what a boy may see as he runs after his ball. Does everything seem safe?

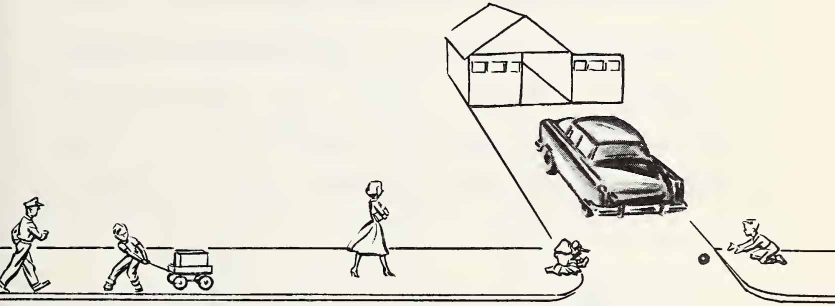
What may happen?

Danger Spots

In the picture on these pages there are many places that are not safe for people who are walking. Find as many of these places as you can. Tell what people could do in each place to keep from being hurt.



Around your school there may be places where people are not safe when they are walking. Make a list of these places. Draw a map showing where they are. Make up some rules that will help keep you safe in these places.

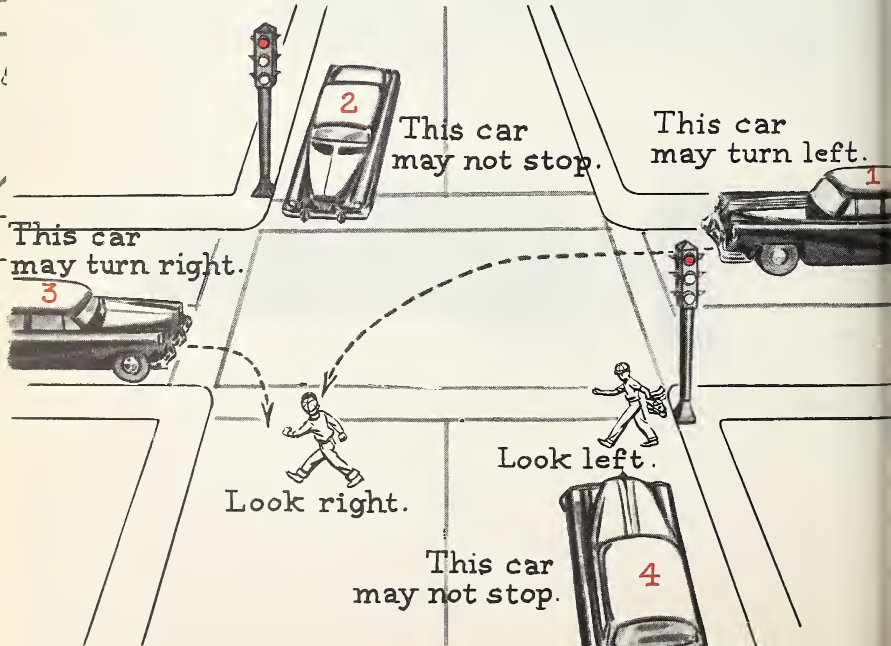


Crossing Streets

Everyone should know how to cross streets safely. Many people are hurt because they do not know how.

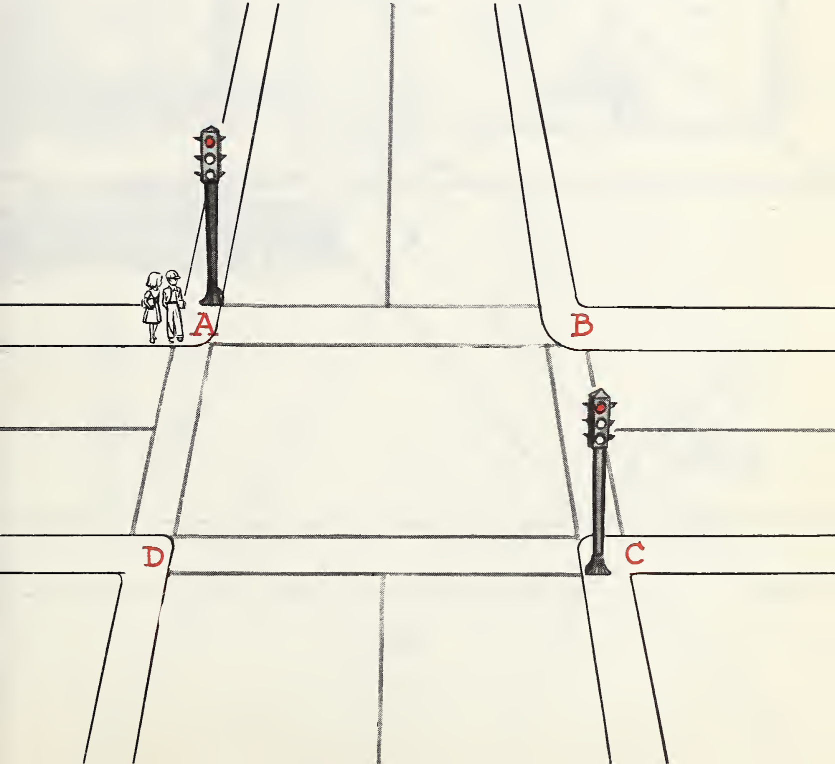
What are three ways an automobile driver may go when he sees a green light? What should a driver do when he sees a red light? Can you be sure he will stop?

You should look both ways before crossing a street. Why? Then you should look left until you reach the middle of the street. Why? Then what should you do? Why?



Tell what you should do when you cross the street from A to B. What should you do when you cross from B to C? How would you cross from B to D?

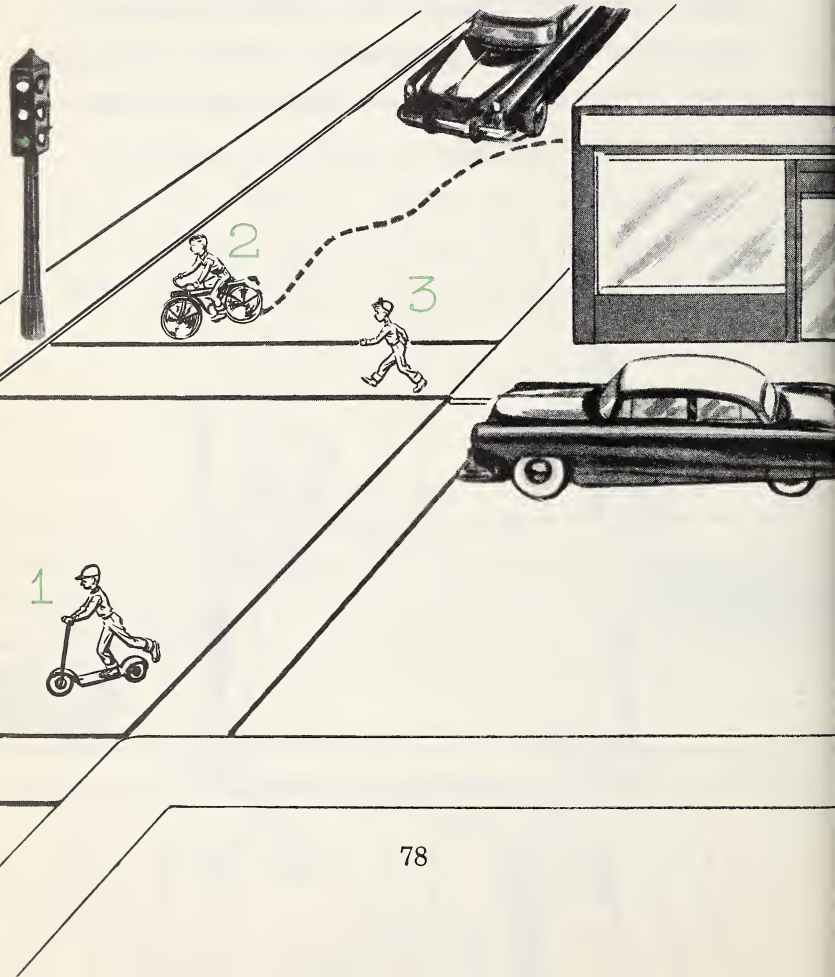
What should you do if there is a policeman at the crossing instead of a light? How do you know when a policeman wants you to cross? How do you know when a policeman wants you to stop?



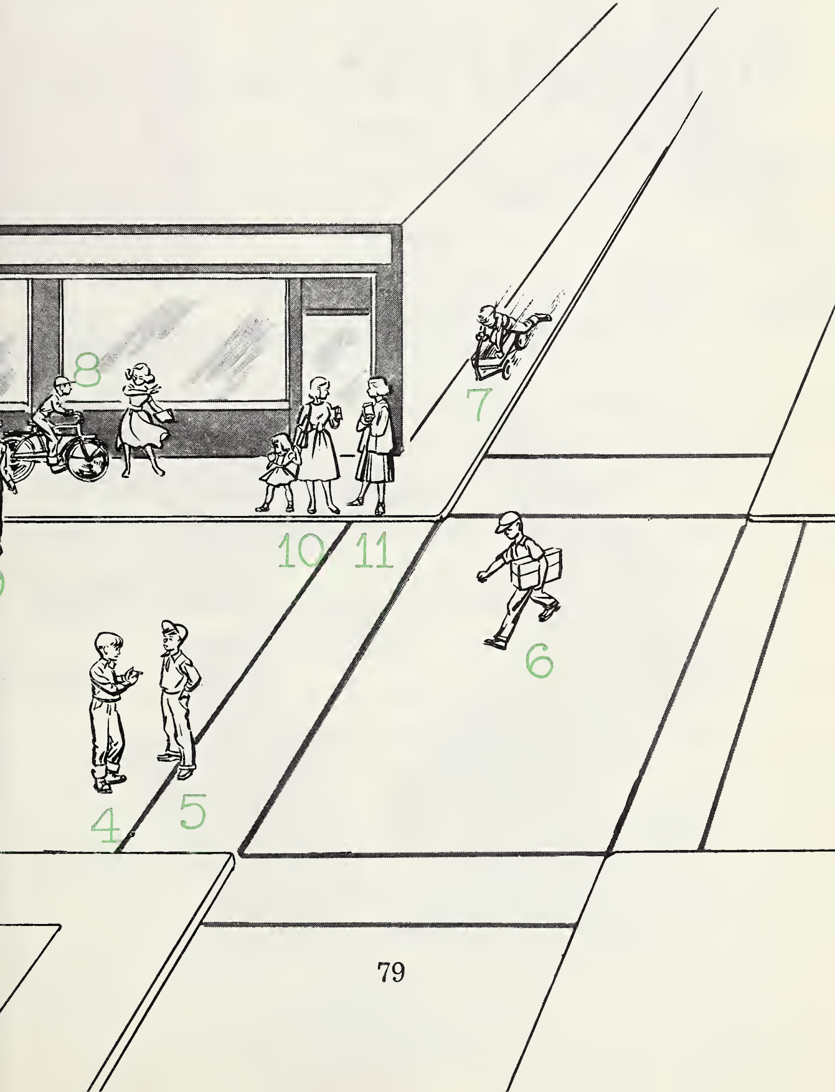
Carelessness

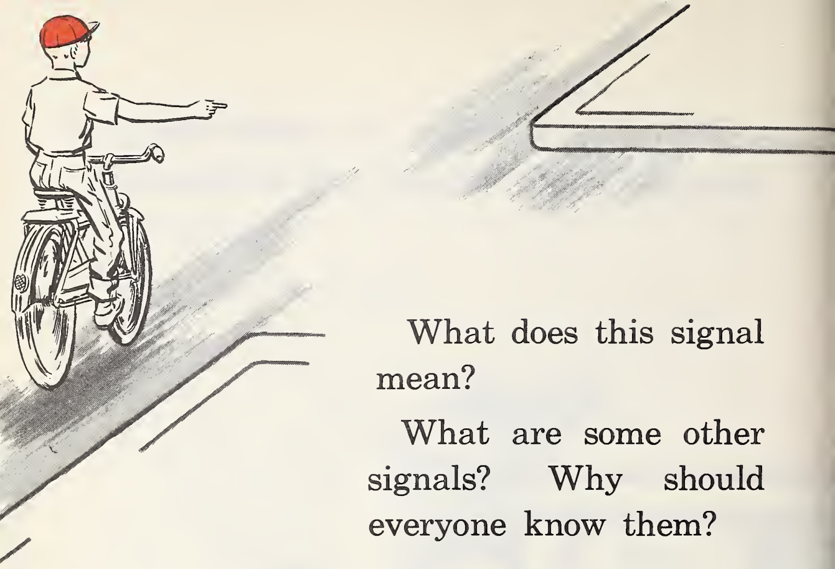
Do accidents just happen or do people do unsafe things?

What do you think?



What unsafe things are people doing in these pictures? Tell why each one is unsafe.





What does this signal mean?

What are some other signals? Why should everyone know them?

---

1. Does a car have more energy when it is moving rapidly or when it is moving slowly?

2. Why does a car going 40 miles an hour need a longer stopping distance than a car going 20 miles an hour?

3. Why is it dangerous to cross a street in the middle of a block?

4. What should you do when you cross a street where there is a light?

5. What should you do when you cross a street where there is no light?

6. What are some good rules to follow when you ride a bicycle?

7. What causes most accidents?

Birds in Winter

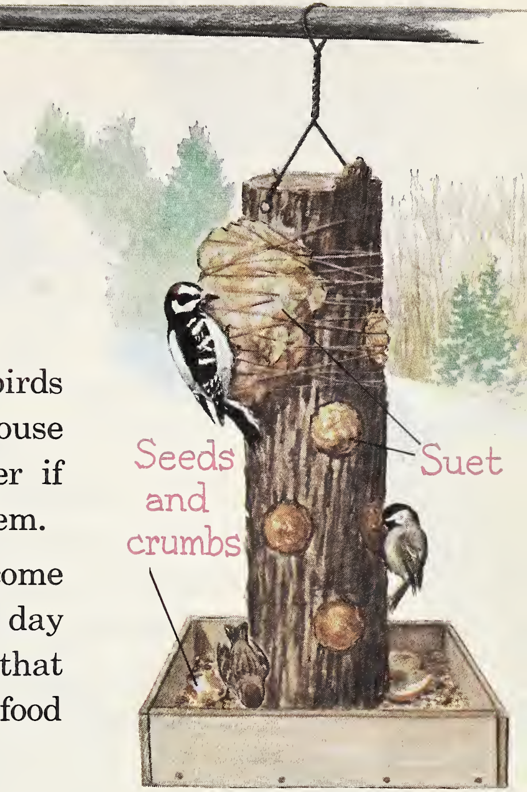
What Birds Eat in Winter

There is not as much food for birds during a cold winter as in summer. Many birds must find different foods when winter comes.

What are some things birds eat in summer? What are some foods they can find in winter?

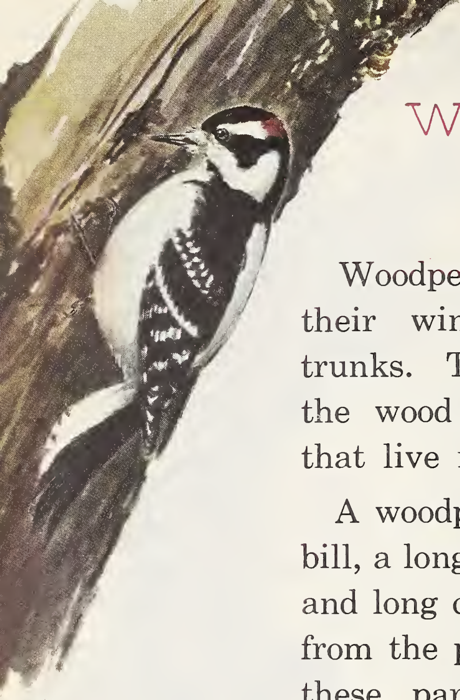
You can have birds around your house during the winter if you will feed them.

The birds will come back day after day when they learn that there is some food for them.



Bird feeder

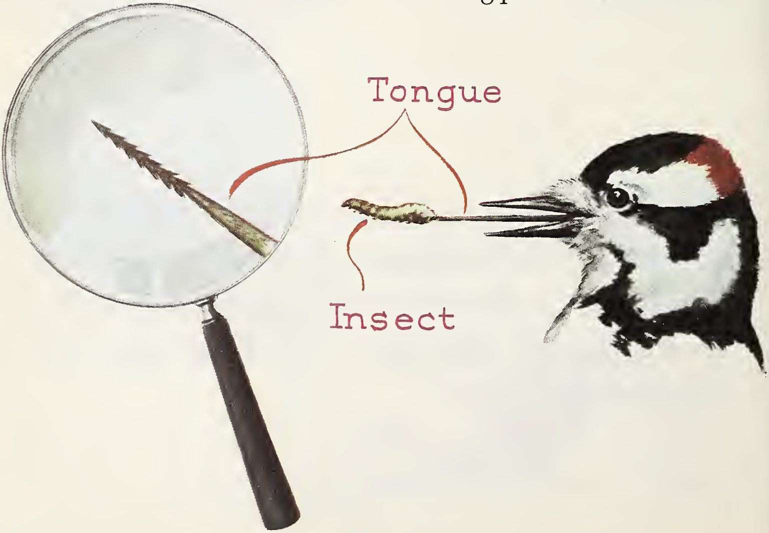
Remember to feed them every day. Birds do not think the same way we do. They will come back again and again even to an empty feeder instead of looking for food somewhere else.

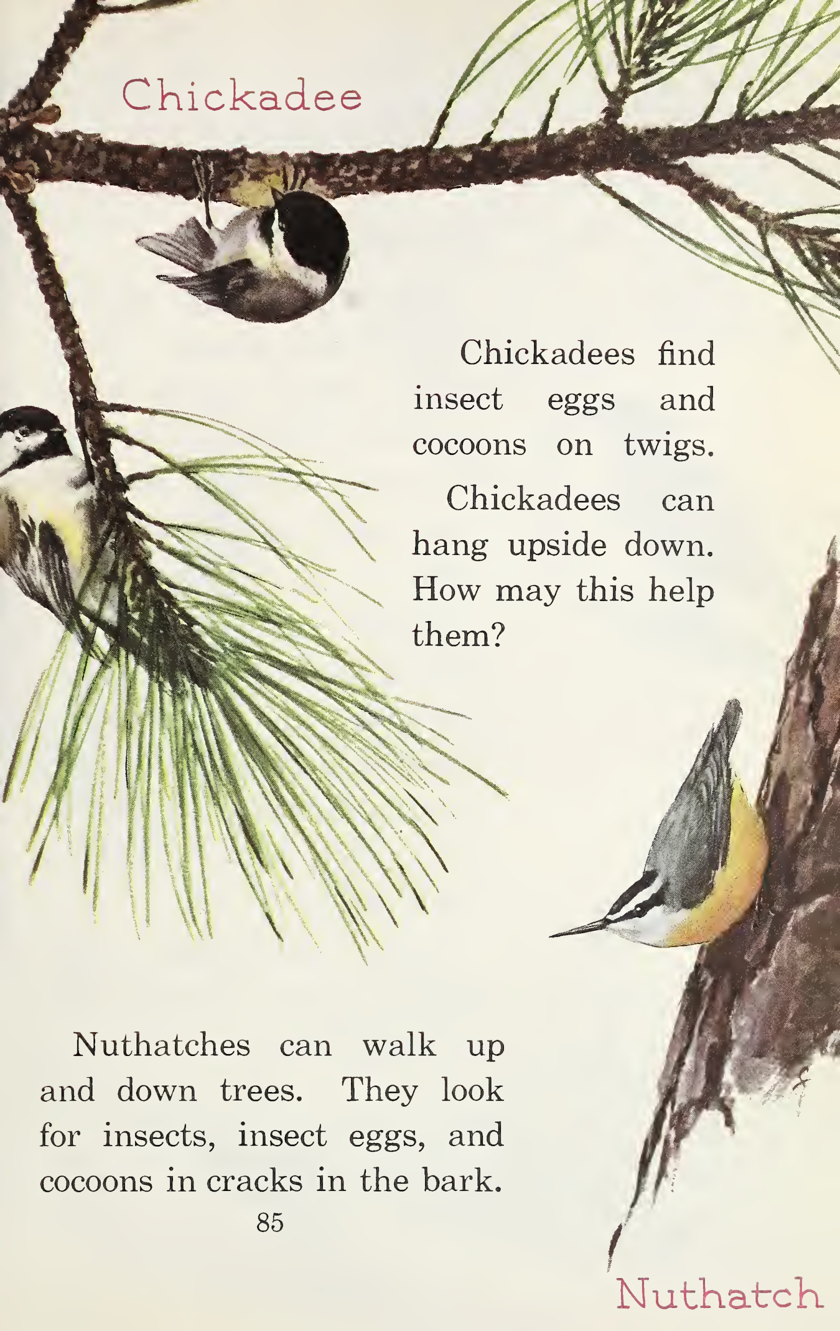


Woodpecker

Woodpeckers find part of their winter food in tree trunks. They make holes in the wood and catch insects that live in the tree.

A woodpecker has a strong bill, a long tongue, a stiff tail, and long claws. Can you see from the picture how each of these parts helps a woodpecker?

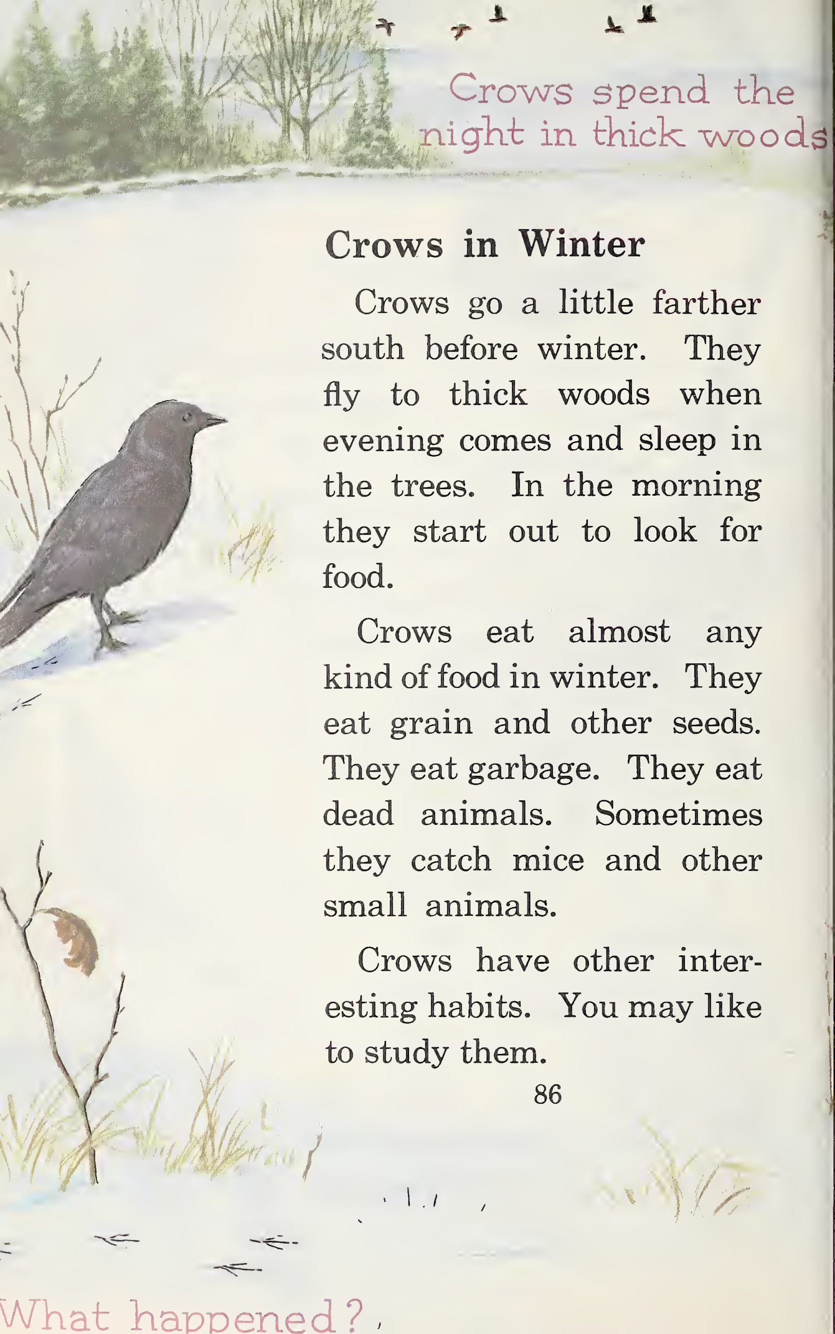




Chickadees find insect eggs and cocoons on twigs.

Chickadees can hang upside down. How may this help them?

Nuthatches can walk up and down trees. They look for insects, insect eggs, and cocoons in cracks in the bark.


Crows spend the night in thick woods
What happened?

Crows in Winter

Crows go a little farther south before winter. They fly to thick woods when evening comes and sleep in the trees. In the morning they start out to look for food.

Crows eat almost any kind of food in winter. They eat grain and other seeds. They eat garbage. They eat dead animals. Sometimes they catch mice and other small animals.

Crows have other interesting habits. You may like to study them.

These crows visited a garbage dump.

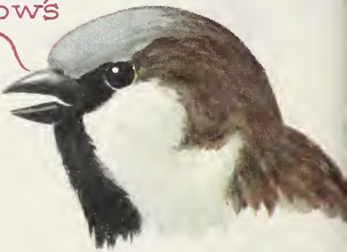
These crows found some corn.

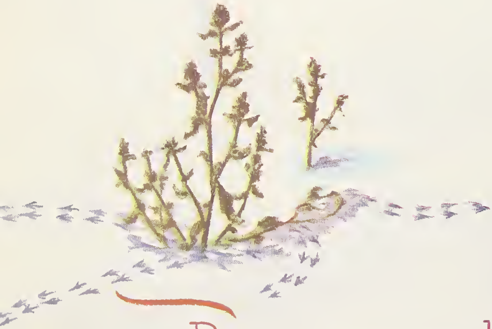
These crows found a rabbit killed by a car.

Winter Birds That Eat Seeds

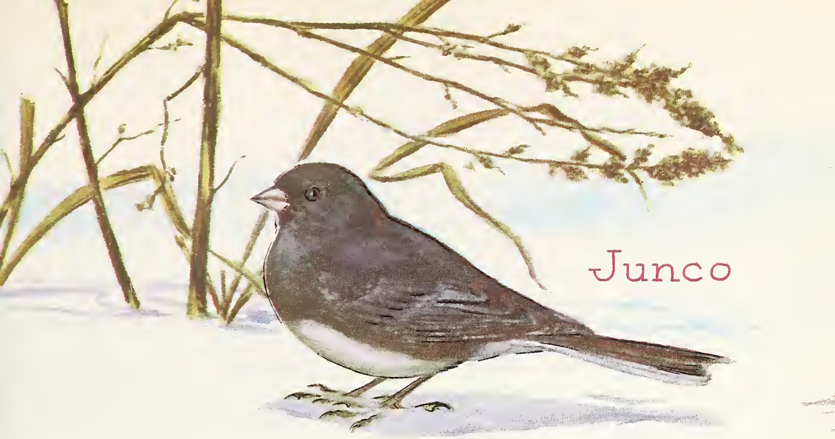
Sparrows look for seeds in the winter. Sometimes the snow is very deep and covers the seeds. Then the sparrows may not find enough to eat.

English sparrow



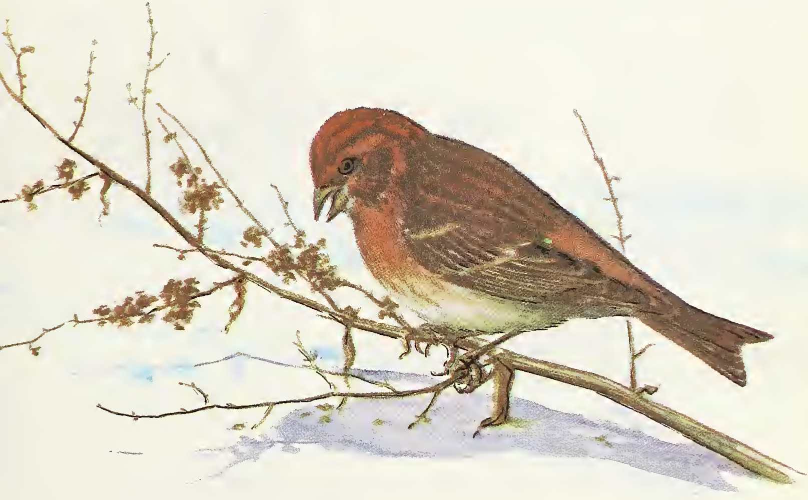


Do sparrows hop or walk?



Junco

In many parts of Canada you may see these two seed-eating birds in winter. They come from farther north where they live in summer.



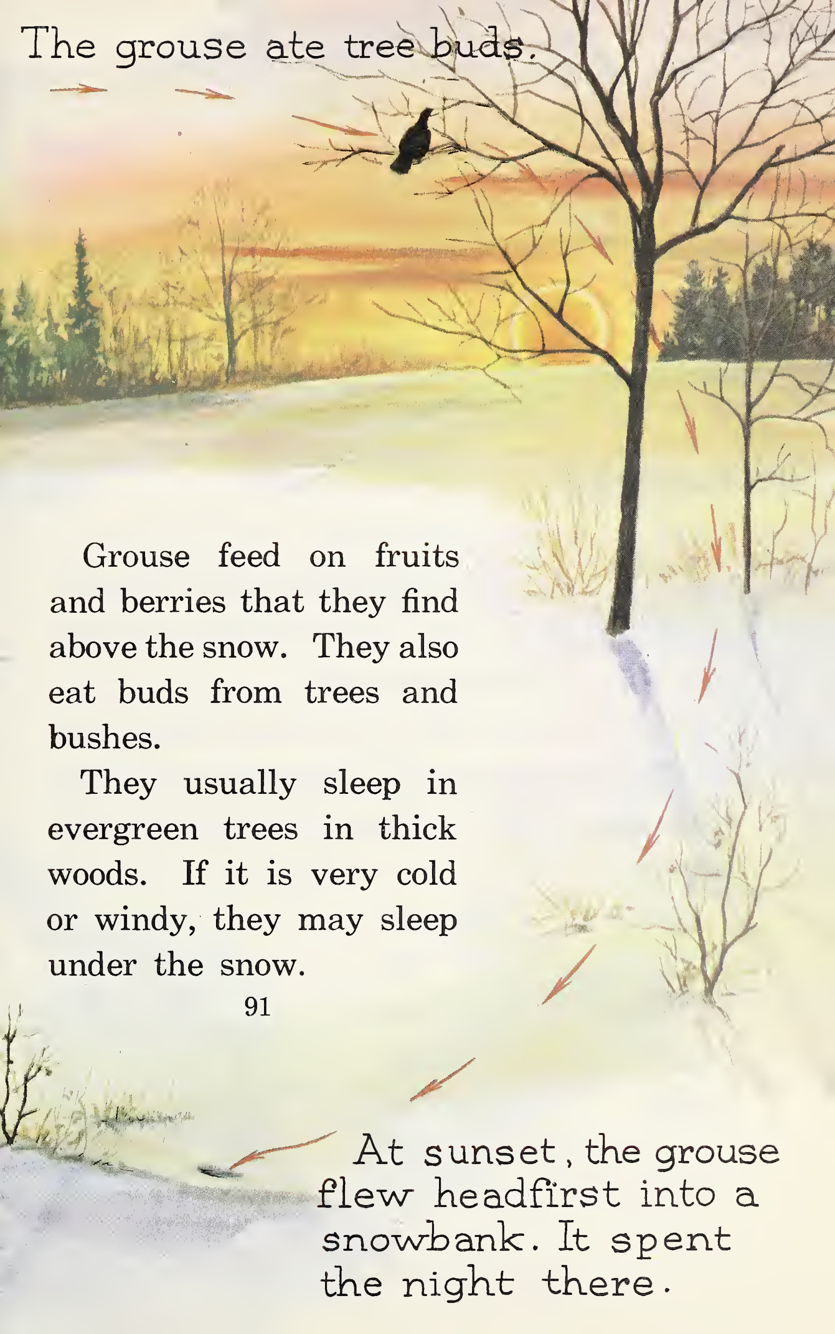
Purple finch

Grouse in Winter

Grouse live in places where the winters are often cold and where the snow is often deep. Many seeds and fruits that the grouse might eat are buried deep under the snow. They must find other foods.

These pages show how the grouse are able to live through the winter.

The grouse ate some fruit from a wild rose bush.



The grouse ate tree buds.

Grouse feed on fruits and berries that they find above the snow. They also eat buds from trees and bushes.

They usually sleep in evergreen trees in thick woods. If it is very cold or windy, they may sleep under the snow.

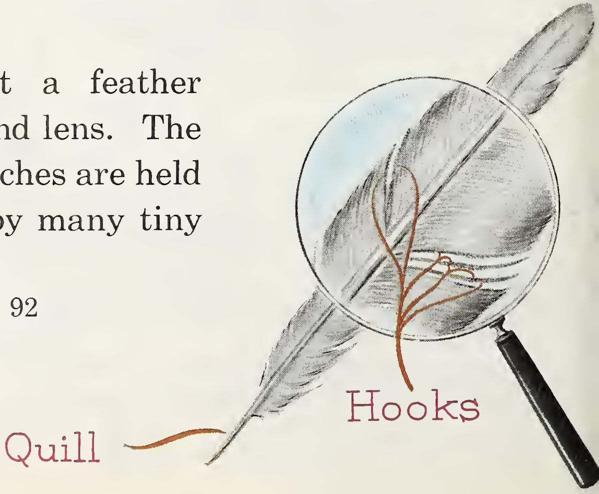
At sunset, the grouse flew headfirst into a snowbank. It spent the night there.

Feathers

Do you know how a bird can keep dry in the rain? Look at the feathers of a pigeon, a canary, or a hen. The feathers overlap like the shingles on a roof.

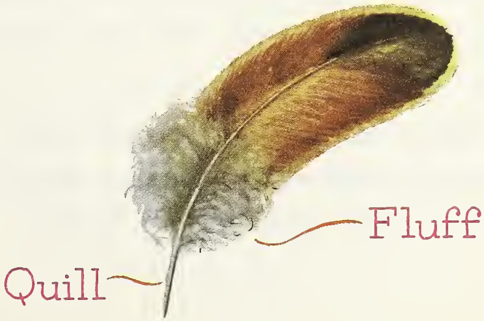
Find a feather and put a drop of water on it. The water runs off. Feathers are covered with oil. Water does not stick to oily things.

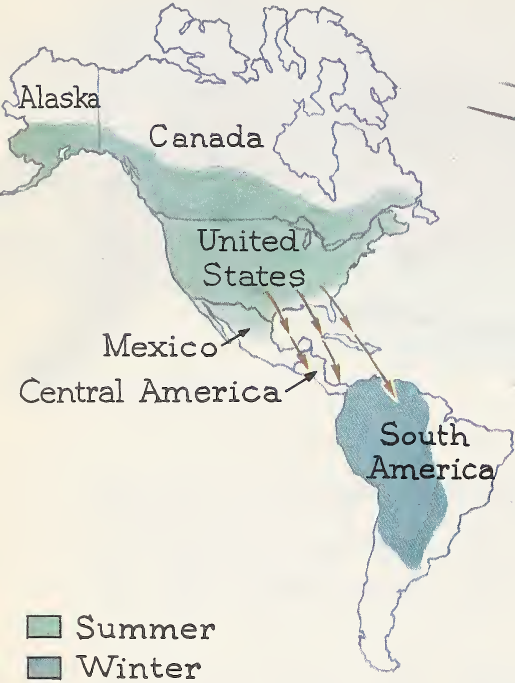
Look at a feather with a hand lens. The little branches are held together by many tiny hooks.



These birds look fat. They have fluffed out their feathers to help keep themselves warm. Feathers are warmer when they are fluffed out.

Some of the feathers on a bird have soft, fluffy parts near the bottom. This fluff helps keep a bird warm.

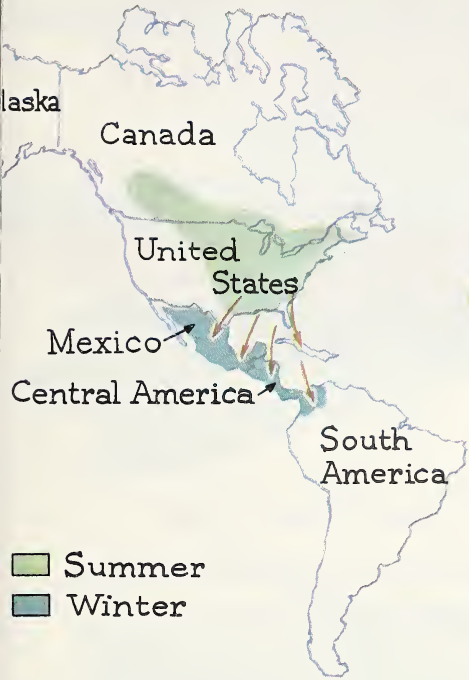




Birds That Go South in Winter

Many birds fly south in winter. Some of them go far away. No one knows how they find their way.

Barn swallows spend the winter in Central America and in South America. They come back in the spring.



Hummingbird

Hummingbirds also fly south in winter. Hummingbirds fly to Mexico and Central America.

Name some other birds which you see in summer but which you do not see in winter. Find out where these birds spend the winter.

These are wild geese flying south.

Find out where they live in the summer and where they live in the winter.

---

1. What are some foods that birds may find in the summer but not in the winter?
2. What do woodpeckers, chickadees, and nuthatches find to eat in winter?
3. What do crows find to eat in winter?
4. What is the shape of a sparrow's bill?
5. What can you do to bring birds to your yard in winter?
6. Do you see as many birds in winter as in summer? Why?

Water in Plants

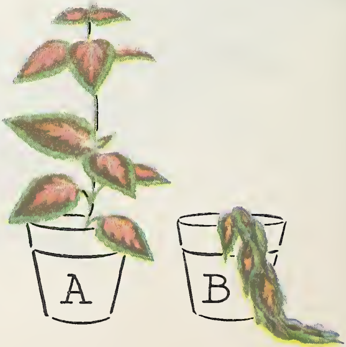
Plants Need Water

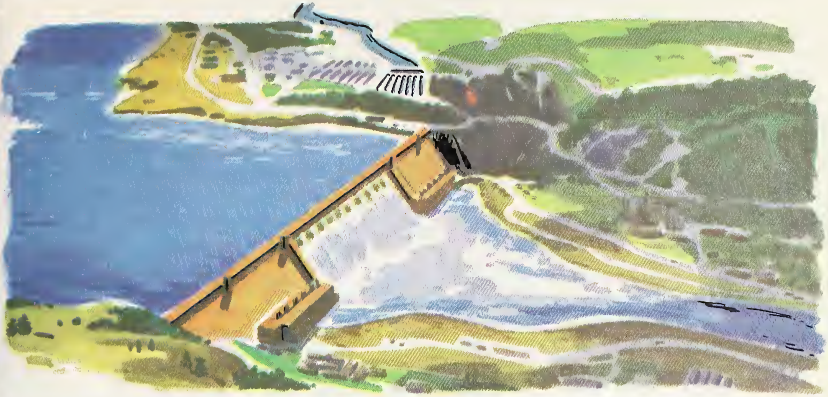
Everyone who has house plants knows that the plants need water. Some house plants must be watered every day.

This experiment shows what happens to plants that do not have enough water.

Use two plants that are about the same size. Water one plant every day for a week. Do not water the other plant. What happens?

Now water the second plant. What happens to it?





In some parts of the country there is not enough rain for growing crops. Dams may be built across rivers to make lakes. Water runs from the lakes through ditches to fields. There the water goes into the soil and helps the plants grow.

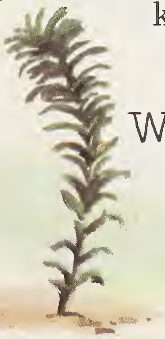
Water Plants

Some plants need much water. Some of them must have their roots in water. Others will grow only under water.

Visit a stream or a pond and collect some water plants. You can keep some of them in an aquarium.

How many water plants do you know by name?

Eel grass



Water weed

Cabomba

Desert Plants

Deserts are hot and dry most of the time, but at certain times of the year it rains.

Desert plants need less water than other plants but they always need some water. They grow fastest during the short rainy season. During very dry seasons they grow very little. When do you think they blossom?

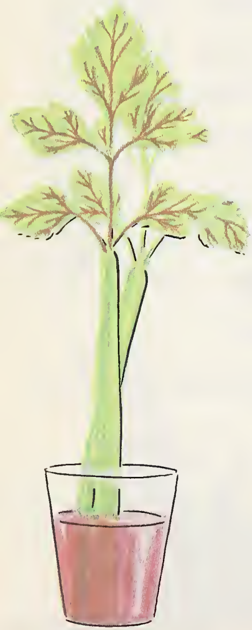
Perhaps you can buy a few desert plants and keep them in your classroom.

Hedgehog cactus

Beavertail cactus

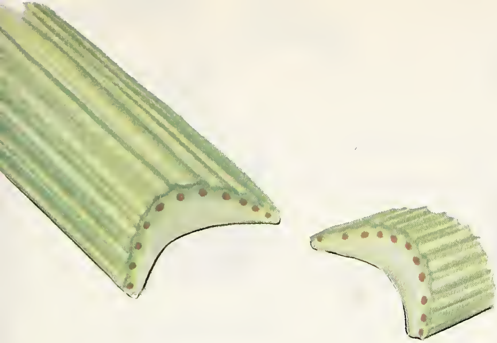
Paths of Water in Plants

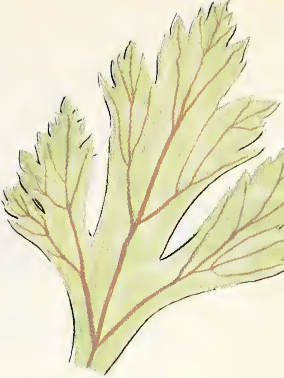
This experiment will show you where some of the water in a plant goes.



Put a stalk of white celery in a glass of water. Add a little red ink. Watch it for a few hours.

You will see the celery begin to change colour. Where did the ink go?

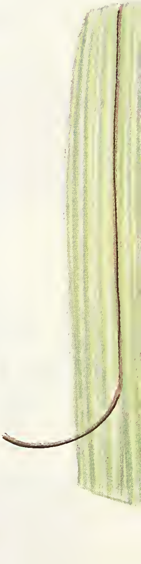


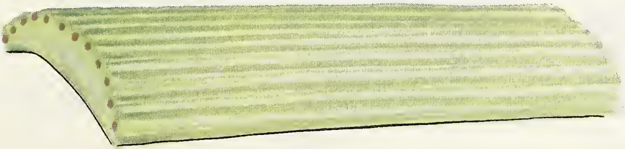


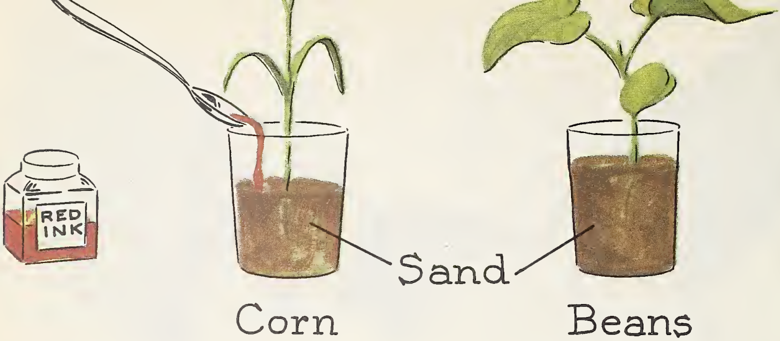
Look closely at the leaf. You will see many red lines. These lines show the paths where water rises in the leaf.

Cut off a piece of the celery stalk. Red spots show where water goes up the stalk.

Break open the stalk along one of the red lines. You can pull out one of the parts that carries water upward. Can you find one of these parts in a celery stalk that has not been in red ink?

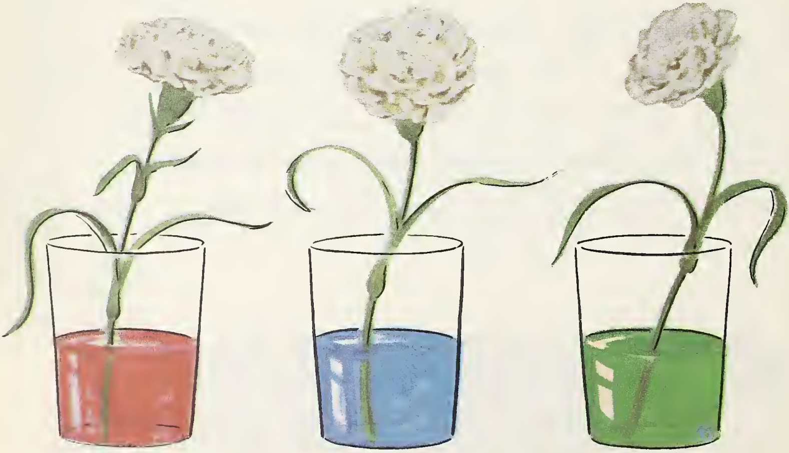






Plant some corn and beans in wet sand. Keep the plants in a dark place so that they are yellow. After both plants have leaves, put some red ink in the sand. Find the paths through which water rises in these plants.

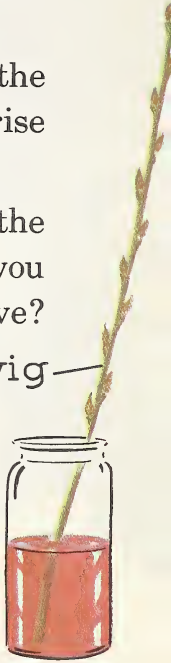
Put some white carnations in ink of different colours. What will happen?

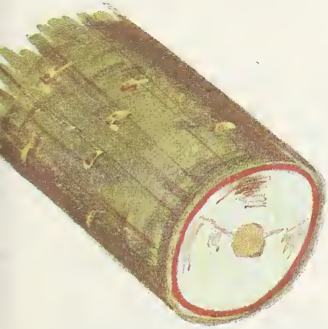


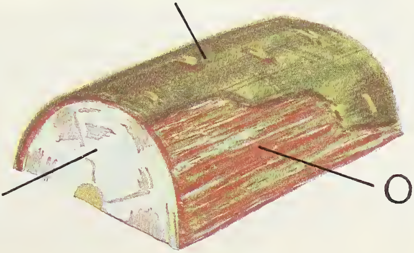
Put a willow twig in red ink. After a day or so, cut the twig open with a sharp knife.

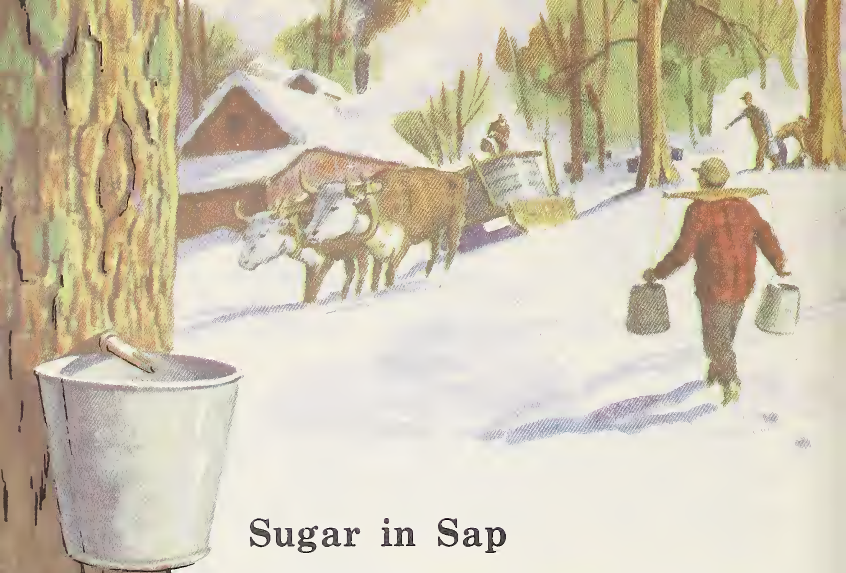
The ink rises in the outer part of the wood, just inside the bark. It does not rise through the bark.

In the same way, water rises through the outer part of the wood in trees. Can you explain why a hollow tree can stay alive?





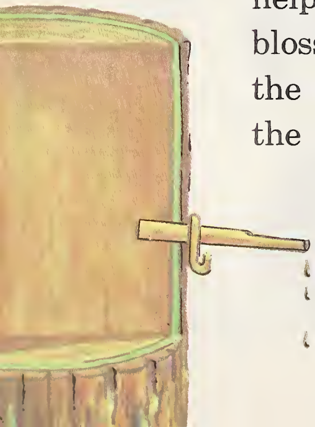


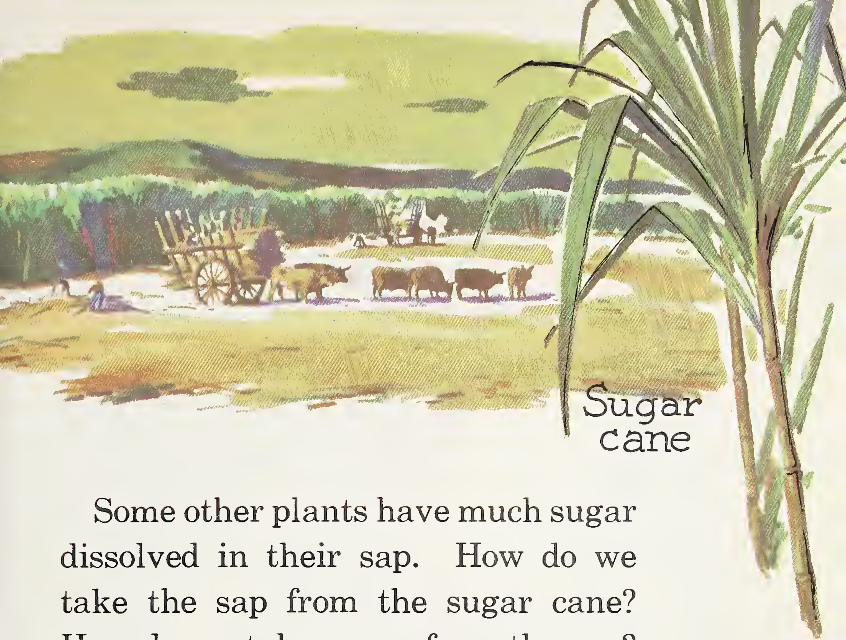


Sugar in Sap

The water in plants is called sap. Maple tree sap has sugar dissolved in it.

A maple tree makes sugar during the summer. It stores the sugar in the trunk and the roots. In spring the sugar is used to help form new leaves and blossoms. We take a little of the sap as it rises to the tops of the trees.





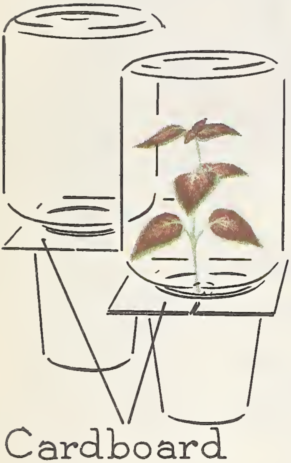
Sugar cane

Some other plants have much sugar dissolved in their sap. How do we take the sap from the sugar cane? How do we take sugar from the sap? Find out how the plants grow.

Find out how we make sugar from sugar beets. Find out how sugar cane and sugar beets are raised.

Sugar beets

Water from Plant Leaves

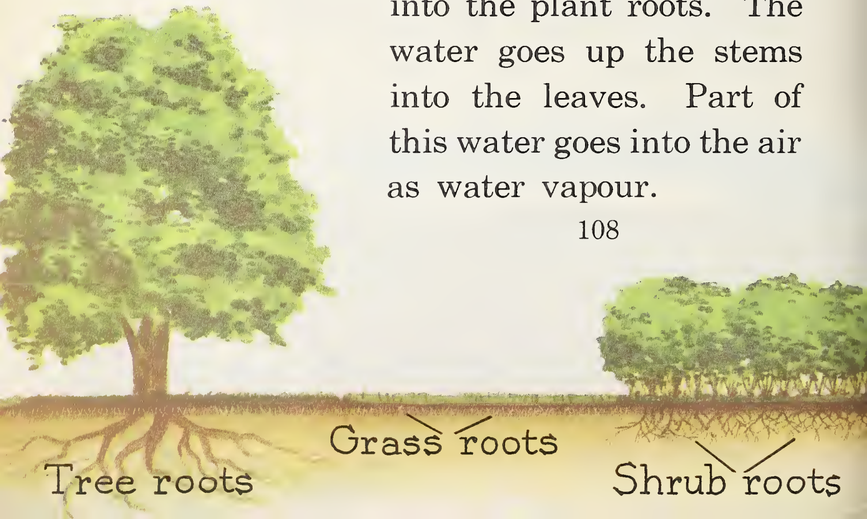


This experiment shows what happens to much of the water that goes into the leaves of plants.

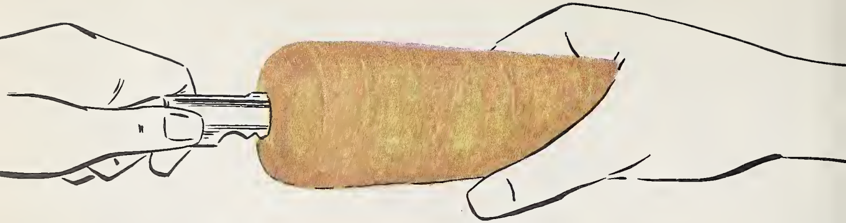
Put cardboard over the soil in two plant pots. Only one pot has a plant in it.

Put a glass jar over each pot. Look at the jars the next day. What happened? Can you tell why?

Water in the soil goes into the plant roots. The water goes up the stems into the leaves. Part of this water goes into the air as water vapour.



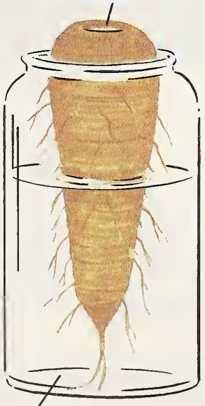
Water goes up the trunks to the tops of these giant trees. Then some of the water goes into the air from the leaves.

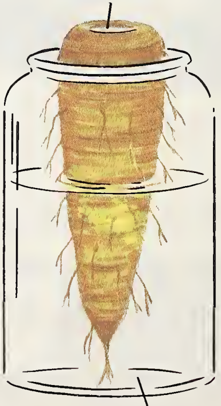


How Water Goes into Roots

Bore a hole in the tops of two carrots. Put a little sugar water in the hole in one carrot. Put the same amount of fresh water in the other carrot.

Set each carrot in a jar of fresh water. After a few hours look at the carrots. Which carrot now has the most water inside? Where did it come from?





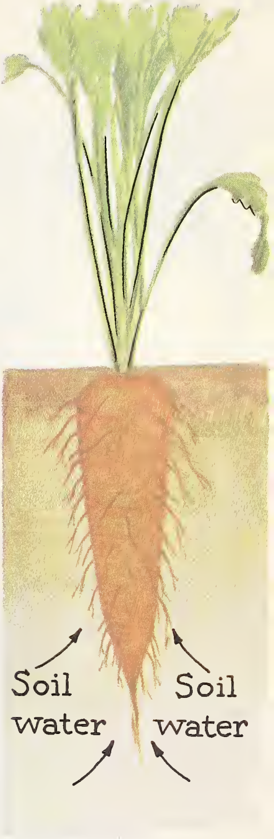
The sap of plants usually has sugar dissolved in it.

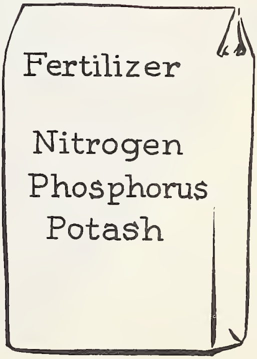
Water in the soil goes into the roots of the plant toward the sugar water, much as it did in your experiment.

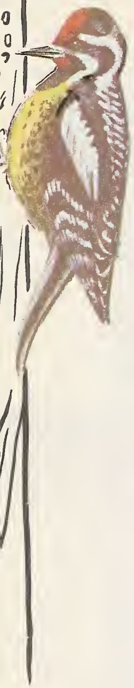
Some of the minerals in the soil dissolve in the soil water. Then they are carried into the roots of the plants.

Plants use some of the minerals in the soil water when they make food for themselves.

Sometimes there are not enough of these minerals in the soil and the plants do not grow well. We can add more of these minerals by putting fertilizer on the soil.







Animals and Sap

This bird is called a "sapsucker." It makes holes in the bark of trees and drinks the sap.

Some insects drink sap. A "spittle bug" uses sap for food. It also uses it for bubbles. How do these bubbles protect a spittle bug?

---

1. What is dissolved in the sap of plants?
2. In what part of a tree does sap rise?
3. How does water get into most plants?
4. Name a plant that needs much water. Name a plant that needs little water.
5. Where does sap rise in a celery leaf?
6. How does fertilizer get into plants?

Static Electricity

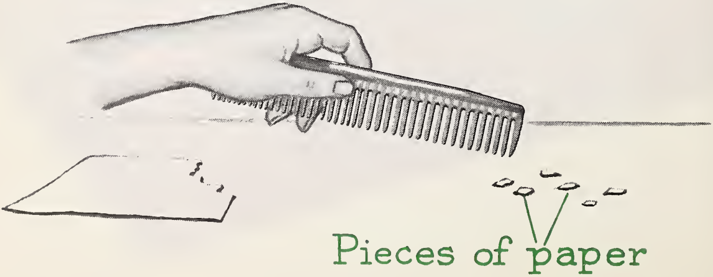
Making Electric Charges

Here are some experiments with electricity that you can do. You will find that they work best on cold, dry days in winter.

Rub a comb rapidly with a wool cloth. Hold the comb near bits of thin paper. What happens?

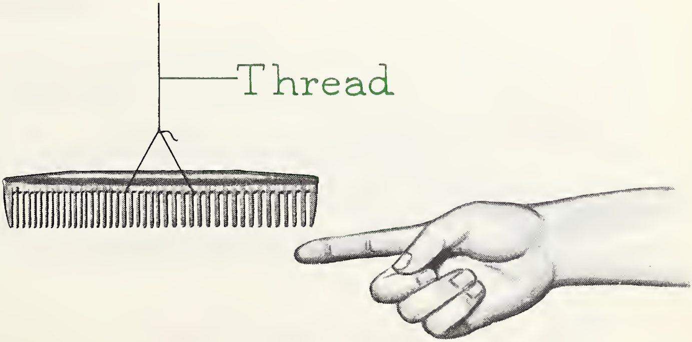
Hold a comb near other things, such as hair, bits of thread, and pencil shavings. What happens each time?

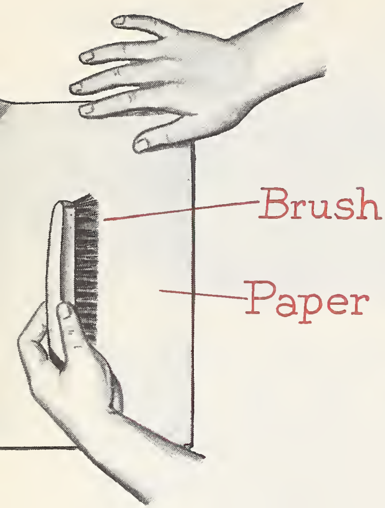
Will a magnet pick up these things? Try it and see. What will a magnet pick up?



Hold a comb that has not been rubbed near a floating bathtub toy. What happens? Rub the comb with a wool cloth and hold it near the toy. Watch the toy move across the water.

Hang a comb by a thread as shown below. Hold your finger near the comb. What happens? Rub the comb with a wool cloth and hold your finger near it. Watch the comb move.

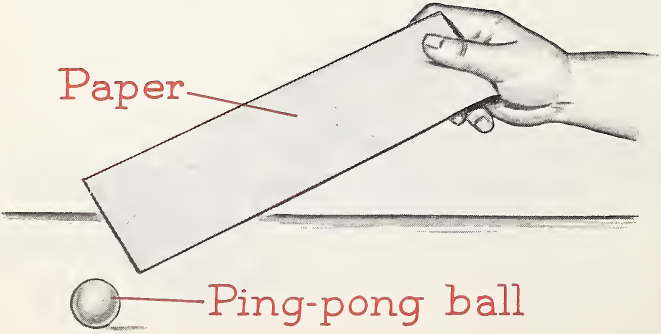




Hold a sheet of paper against the blackboard and rub it rapidly with a brush. Take your hands away. What happens?

Rub a sheet of paper with a brush. Hold one corner of the paper near a Ping-pong ball. What happens?

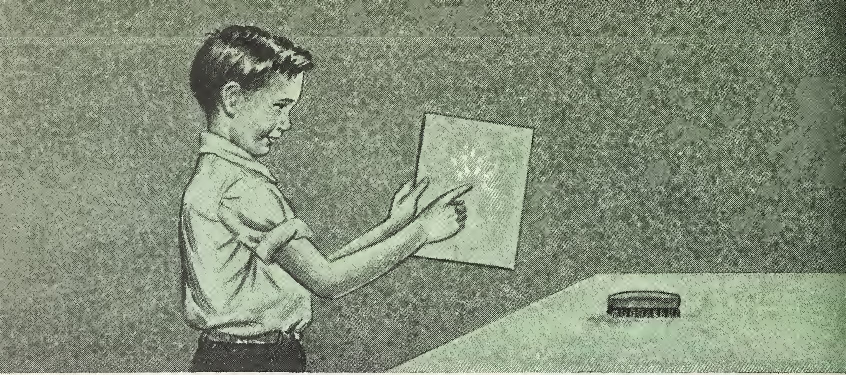
Now try these experiments without rubbing the paper. Must you rub the paper to make it do these things?



Rub a balloon with a wool cloth. Hold the balloon near your body. What happens?

Hang the balloon by a thread. Rub the balloon with wool and walk near it. What happens?

Rubbing the balloon gives it energy. Because it has energy, it is able to move. We call this kind of energy electrical energy. We say that something with electrical energy is charged with electricity.



Electric Sparks

You will need a darkened room for this experiment. Perhaps you can do the experiment at home after supper.

Rub a sheet of paper with a brush. Then hold it in front of you and move one finger across it. Can you see little flashes of light? These are electric sparks. Can you hear anything?

Comb your friend's hair in the dark or rub your cat's fur in the dark. Can you see sparks? Can you hear these sparks snapping?

Lightning is a big electric spark. Sometimes the tiny drops of water in clouds become charged with electricity. The charges may be strong enough to jump to other clouds or to the ground. This makes an electric spark we call lightning.

In your experiment in the dark, you saw little flashes of light. You heard faint noises, too. The electric charges in clouds have much more energy than the charges you gave the paper. The sparks are much bigger and brighter, and the noises they make are much louder. What do we call the noise that lightning makes?

Safety from Lightning

Not many people are ever hurt by lightning. We need only a few simple rules to keep us safe. We should remember that lightning follows easy paths to the ground. We should try to stay away from these paths.

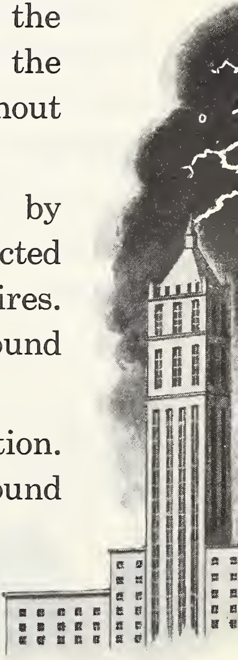
A tall tree standing alone makes a good path for lightning. You should not be under one during a thunderstorm. You should not stand in a field or on top of a hill. In a woods it is better to stay under the lower trees.

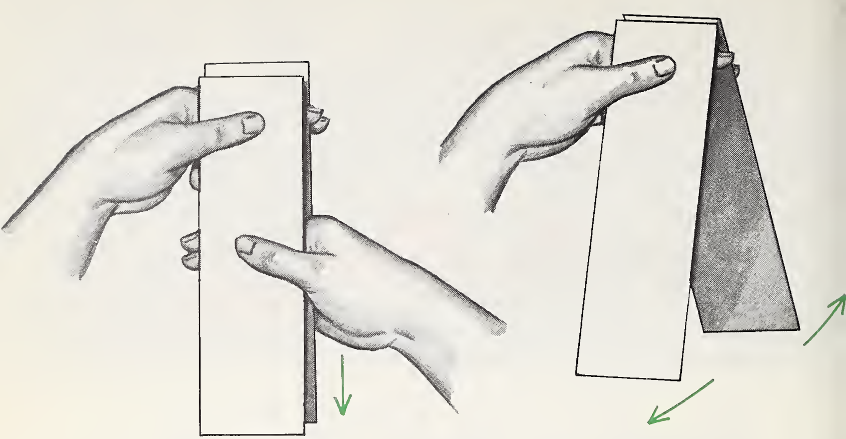
Electricity in thunder clouds has enough energy to set fire to wooden buildings. Many farm buildings burn because of lightning.

Metal roofs can be connected to the ground by wires or pipes. Then the electricity goes to the ground without doing any harm.

Buildings can be protected by lightning rods. The rods are connected to the ground by large wires. Electricity can go to the ground through the wires.

Metal buildings need no protection. The electricity goes to the ground through the metal.



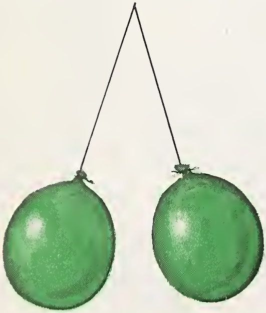


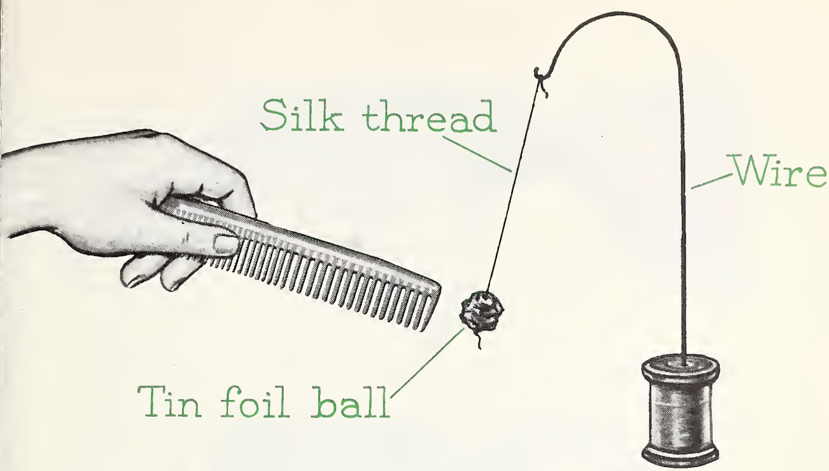
Charged Things May Push Away from Each Other

Hold two strips of paper as shown in the picture above. Rub them by pulling two ends rapidly through your fingers. Notice what happens.

You already know that when something is charged it pulls on things that are not charged. Now you see that two pieces of charged paper push each other.

Hang two balloons by threads. Rub each balloon with wool. What happens?



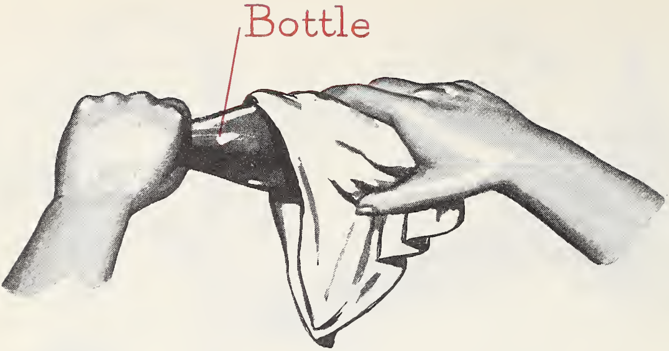


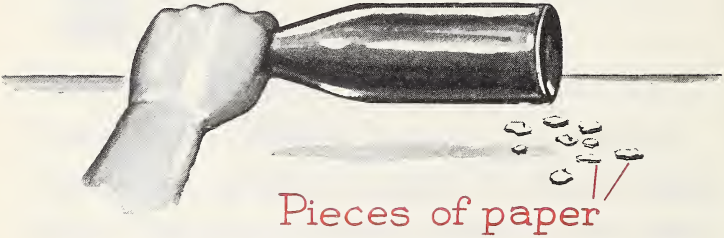
Make a little ball of tin foil. Hang it by a silk thread. Charge a comb by rubbing it with wool. Bring the comb near the ball of tin foil. What happens?

At first the ball has no charge. It is pulled by the charged comb.

When the ball touches the comb, part of the charge in the comb goes into the ball. You may hear the spark as the electricity jumps to the ball.

Now the ball has the same kind of charge as the comb. Can you explain why the ball flies away from the comb?



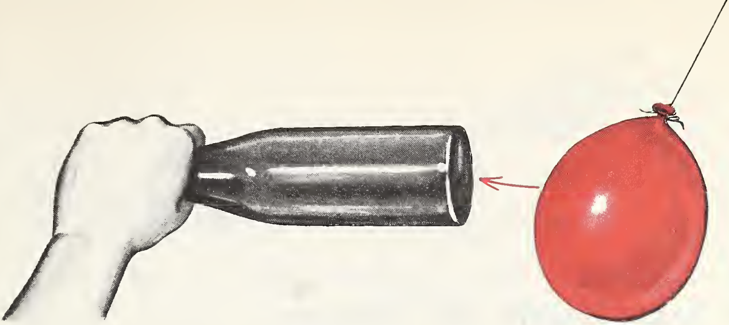


A Different Charge

Rub a glass bottle with a silk cloth. Hold the bottle near bits of thin paper. Can it pick them up?

Will the bottle pick up hair, bits of thread, and other light things?

Rubbing the bottle with silk charges it with electricity.

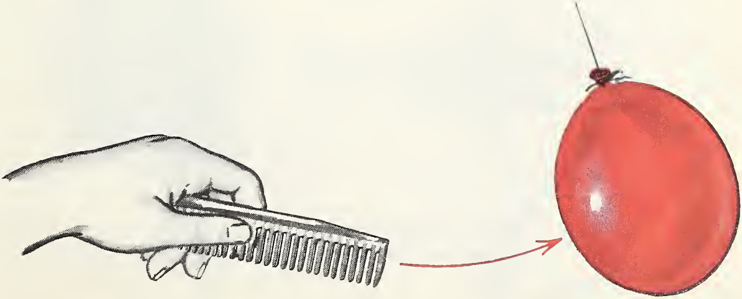


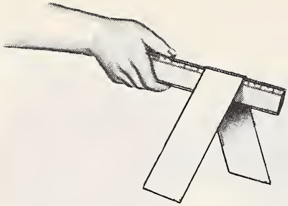
Hang a rubber balloon by a thread. Give the balloon an electric charge by rubbing it with a wool cloth.

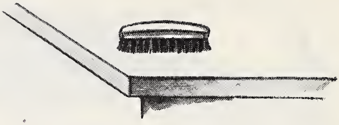
Rub a glass bottle with silk. Hold it near the balloon. What happens?

Rub a comb with wool. Hold it near the balloon. What happens?

We know that the bottle is charged because it picks up bits of paper. We know that the comb is charged. But we know that the two kinds of charges are not the same. We have found a new kind of charge.







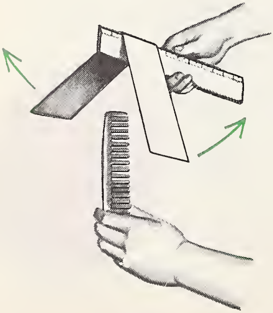
Two Kinds of Charges

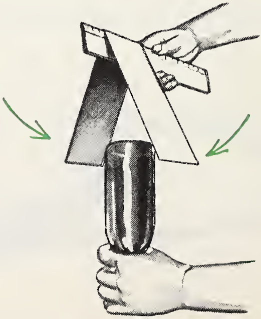
Charge a long strip of paper by laying it on a table and brushing it rapidly. Then lay the paper over a ruler as shown above.

Charge a comb by rubbing it with wool. Hold the comb beneath the paper. What happens?

Charge a bottle by rubbing it with silk. Hold the bottle beneath the paper. What happens?

The comb and the paper push each other apart. We say that they have like charges. The bottle and the paper pull each other. We say that they have unlike charges.

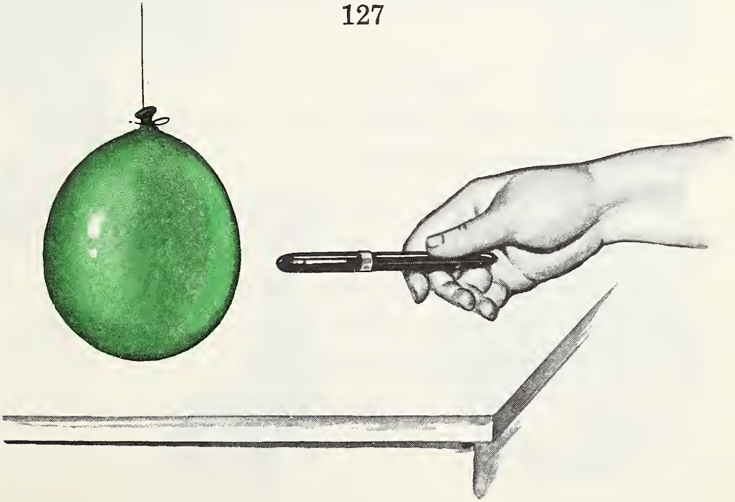


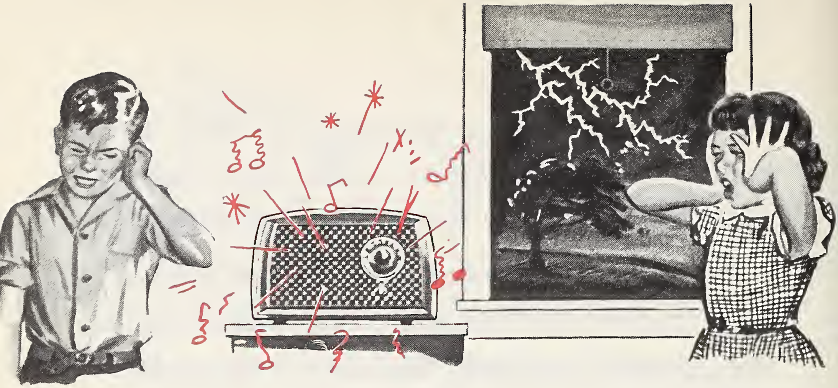


Scientists have experimented with electricity for many years. They now believe that there are only two kinds of charges.

One kind is the charge on rubber that has been rubbed with wool. The other kind is the charge on glass that has been rubbed with silk.

Rub different things with different kinds of cloth and test them. First bring each one near bits of thin paper to see if it has a charge. Then bring each one near a charged balloon. If it pushes away the balloon, it has the same kind of charge as the charge on rubber. If it pulls the balloon, it has the same kind of charge as the charge on glass.



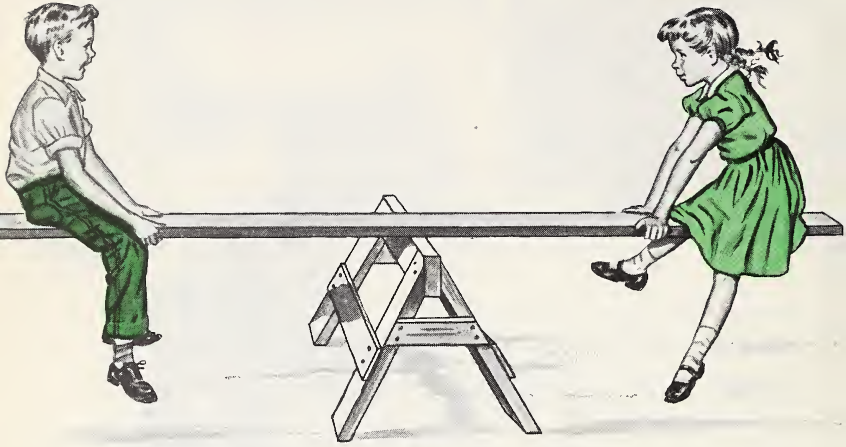


What is happening to the radio? Have you ever heard loud noises on your radio during a thunderstorm?

Make some electric sparks by rubbing your feet on a rug. Do the sparks make any noises on the radio?

1. How many kinds of electric charges are there?
2. What is lightning?
3. Name some places that are dangerous during a thunderstorm.
4. What happens when things with unlike charges are brought near each other?
5. What are lightning rods?
6. How do you know that things with electric charges have energy?

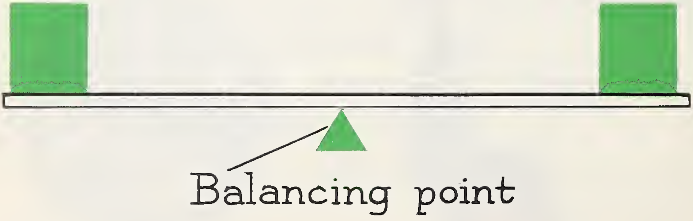
Balancing Forces

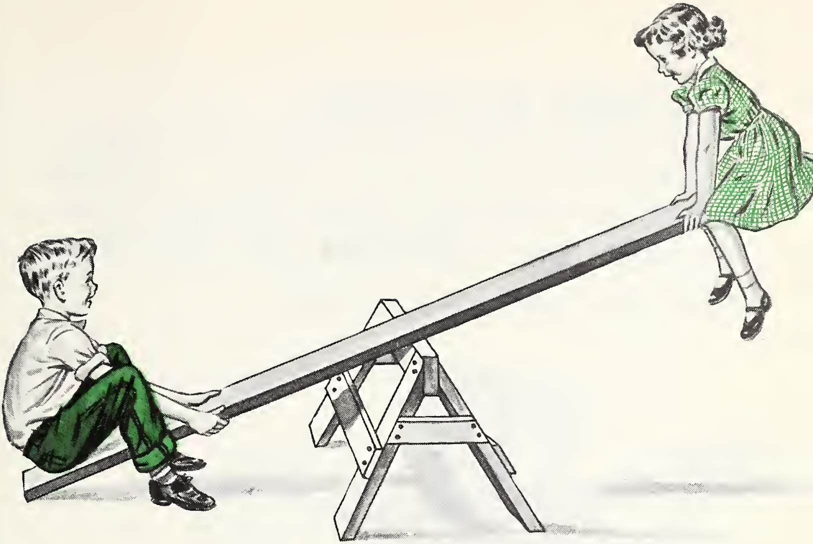


Balanced Forces

This boy weighs as much as the girl. The earth pulls down on each one with the same force. The seesaw is balanced.

Can you think of more things that are balanced?

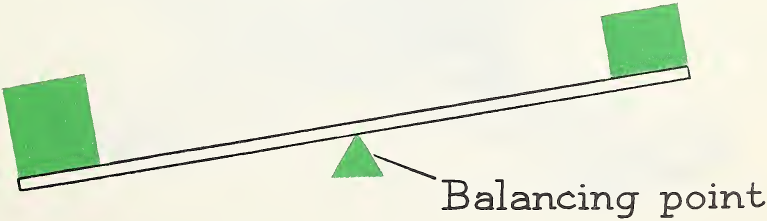




Unbalanced Forces

This boy weighs more than the girl. The earth pulls down more on one side than it pulls down on the other. The seesaw is unbalanced.

Can you think of other things that are unbalanced?

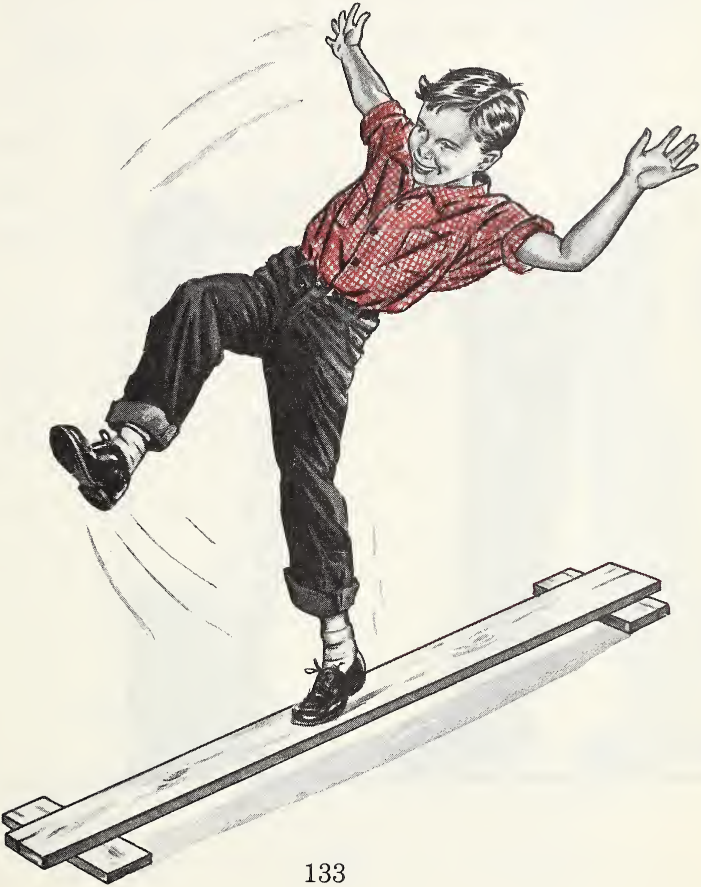


Balancing on a Board

This boy is balanced on a board. Half his weight is on one side. Half his weight is on the other side. The earth pulls down with the same force on each side.

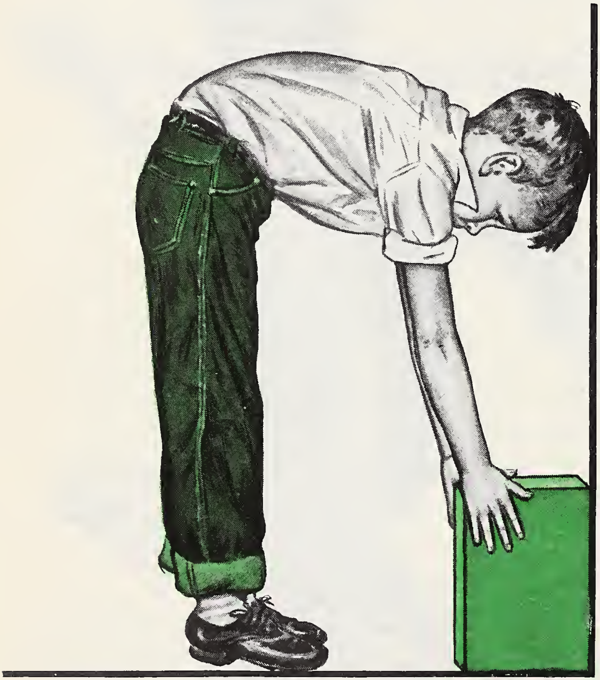
In this picture the boy put more of his weight on one side of the board than on the other.

Tell why he is tipping over.



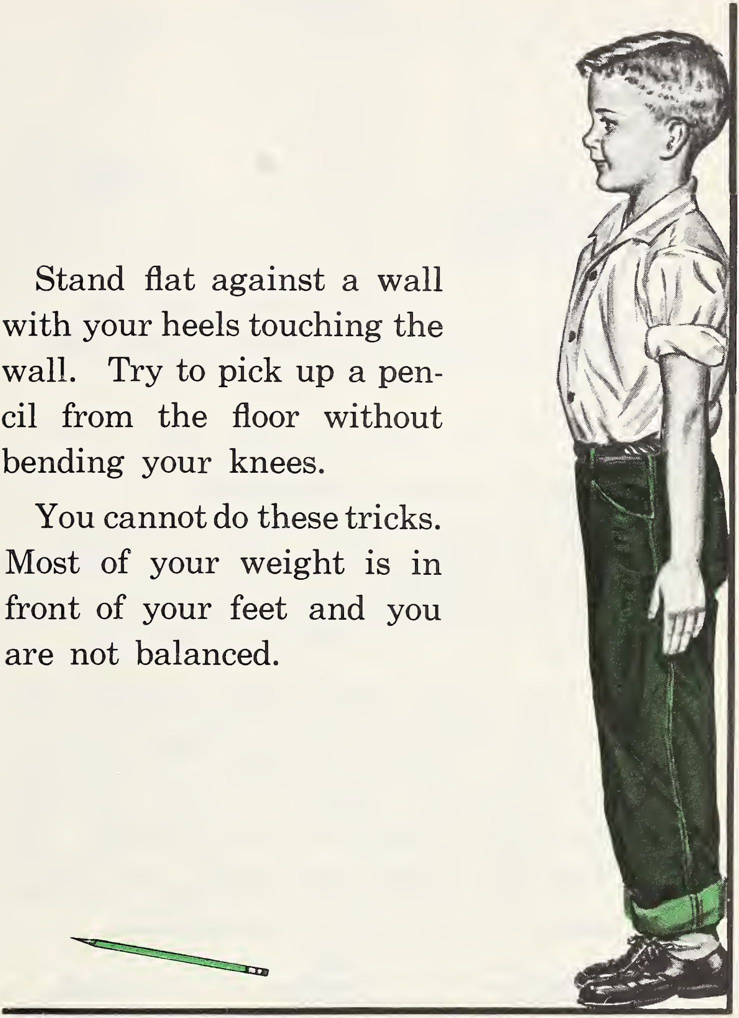
Balancing Tricks

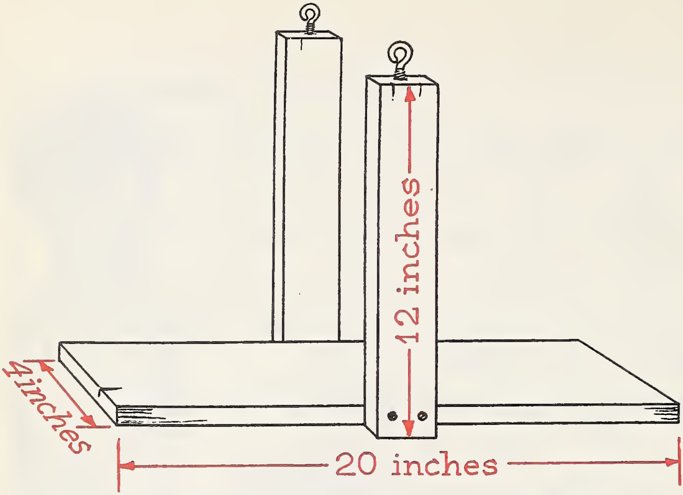
Put a small box on the floor near a wall. Stand about two feet from the wall and place your head against the wall. Without bending your knees, reach down for the box. Try to lift the box and stand up straight.



Stand flat against a wall with your heels touching the wall. Try to pick up a pencil from the floor without bending your knees.

You cannot do these tricks. Most of your weight is in front of your feet and you are not balanced.

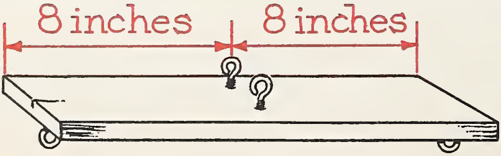


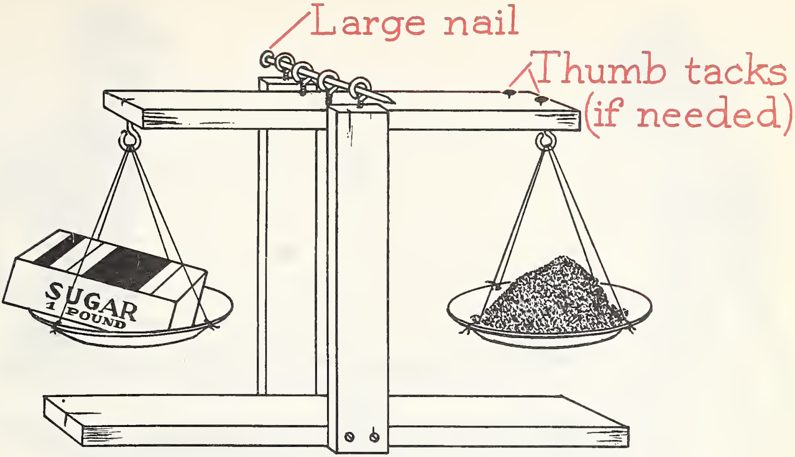


Weighing with a Balance

These pictures show how to make a balance for weighing out small things. Can you guess why it is called a balance?

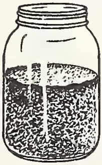
The top picture shows how to make the base. The bottom picture shows how to make the balance arm. Be sure that the two top screw eyes are in the middle. Be sure that the bottom two screw eyes are at the same distance from the middle.

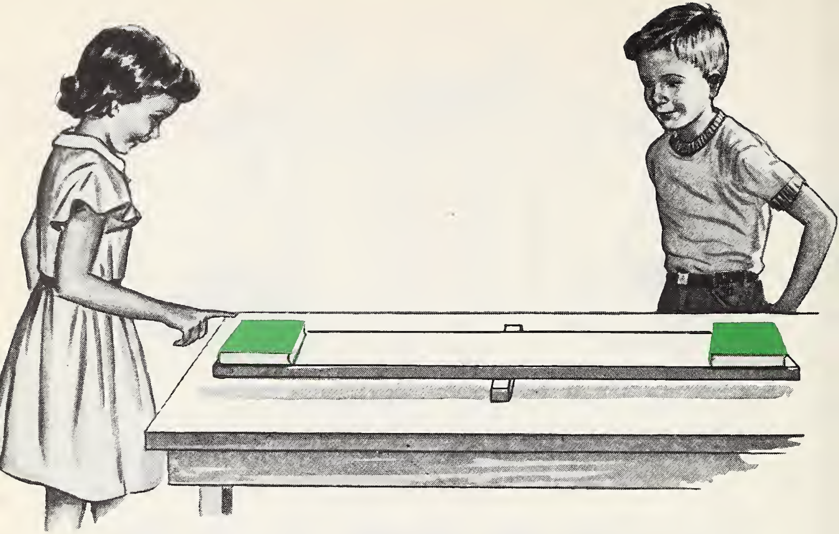




Put a long nail through the four screw eyes on the top of the balance. Hang paper plates from the screw eyes at the ends of the balance arm. If the balance arm is not level, put thumb tacks in one end until it balances.

Put a one-pound weight on one plate. Now weigh out one pound of sand. Weigh out a pound of nails. Weigh out other things. Can you think of a way to weigh out a pound of water?

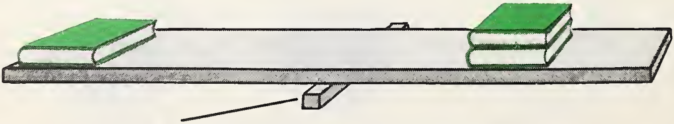


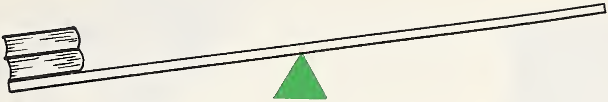


Balancing Books

Find a light board three or four feet long. Balance it on a block of wood. Put a book on each end. Try to find two books that weigh the same. Do they balance?

You can balance two books with one book by putting them on the board as shown below. Try it. What are some ways you can balance the books shown on the next page?





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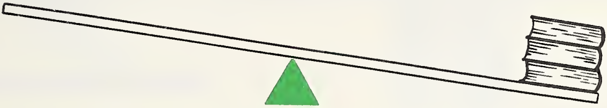

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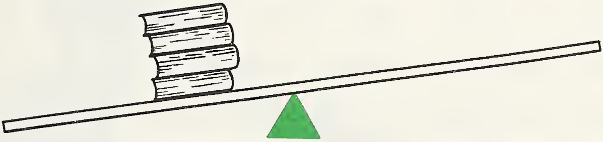

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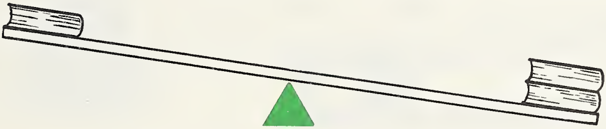

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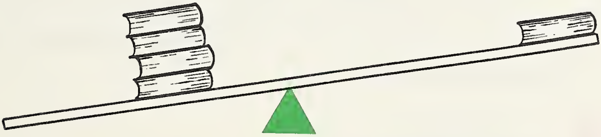

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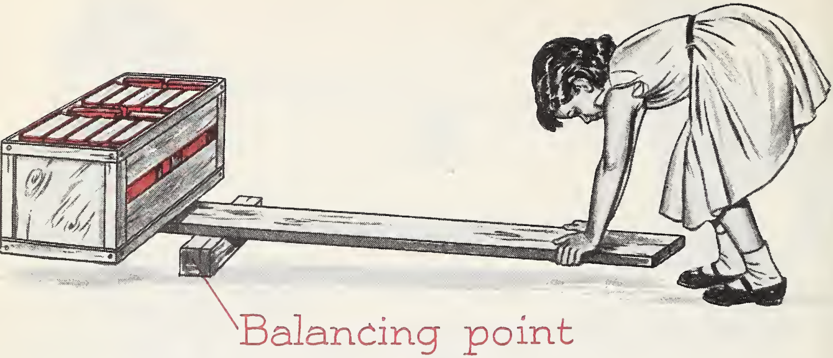
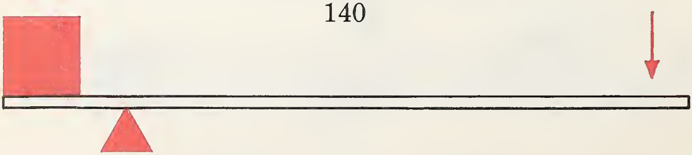


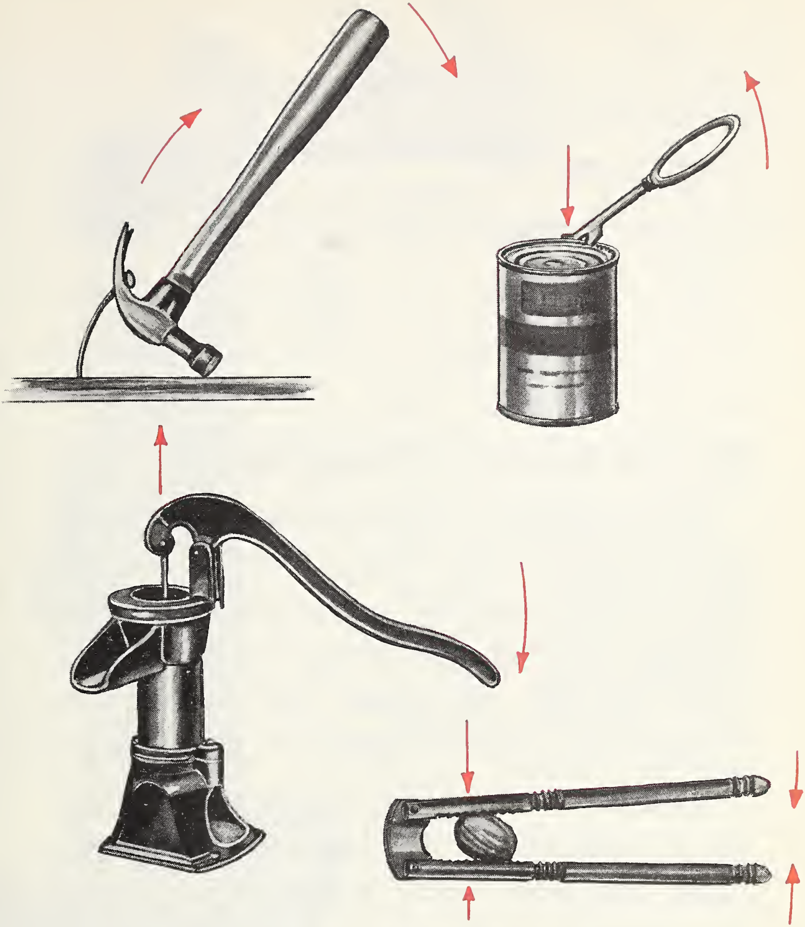
Levers

Try to raise a box of books as shown in the picture above. We call a board used like this a **lever.** Where should you put your hand to make the lifting easiest?

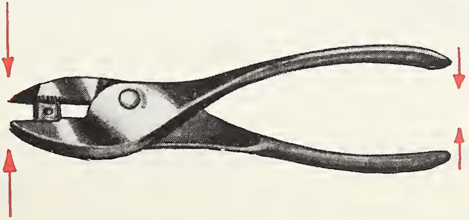
You can lift a box of books this way using less force than when lifting it with your hands alone. The farther you put your hands from the balancing point, the easier it is to raise the box.

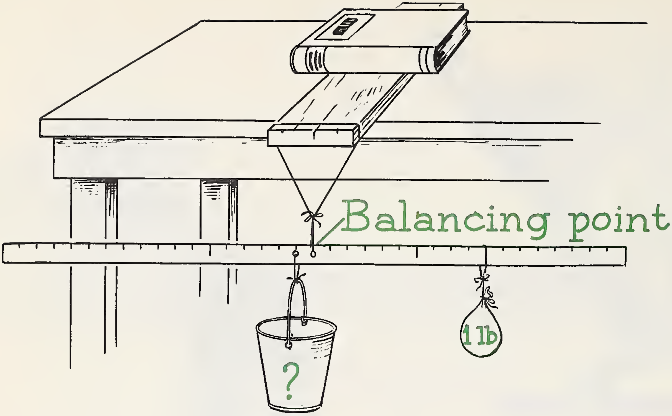
This is somewhat like the experiments with balancing books. A heavy book can be balanced by a light book that is farther from the balancing point.





Here are some other kinds of levers. How do we use them?



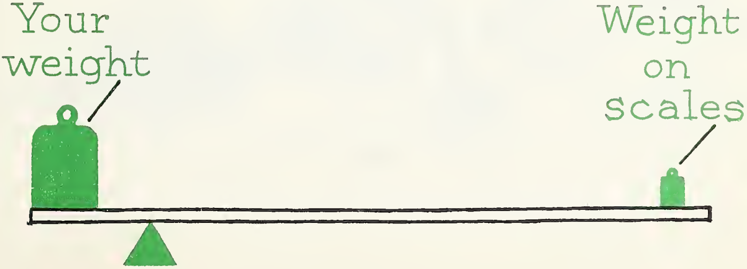


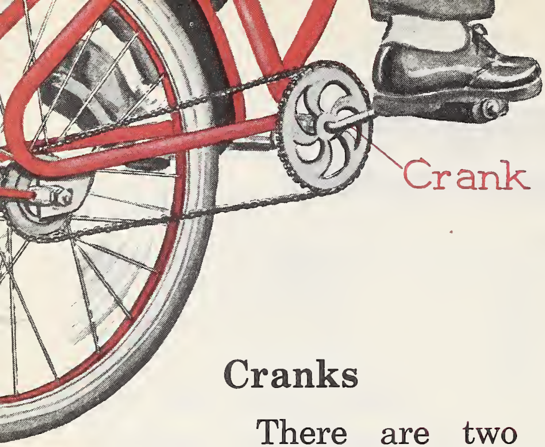
More Levers for Weighing

Here is another kind of weighing balance that you can make. Make a small hole at the 18-inch mark of a yardstick. Make another hole at the 17-inch mark. Run cords through the holes and fasten the balance to a table as shown in the picture.

Hang something heavy to the cord through the 17-inch hole. Slide a one-pound weight along the lever until it balances. Count the number of inches between the one-pound weight and the balancing point. This will give you the number of pounds the heavy object weighs.

The scales you use for weighing yourself may be like the one you just made. At the top of the scales is a small weight that slides along a lever until it balances your weight. Then you read your weight on the lever.





Cranks

There are two cranks on a bicycle, one on each side. A crank is a lever that goes around and around.

Does a crank turn more easily if it is long or if it is short?

---

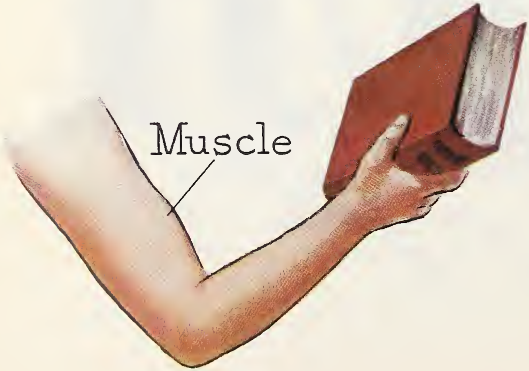
1. Why do some things tip over?
2. How can a light person balance a heavy person on a seesaw?
3. How can you use a balance to weigh things?
4. How do we use levers to help us move things?
5. When you weigh yourself, how can a small weight be made to balance your weight?

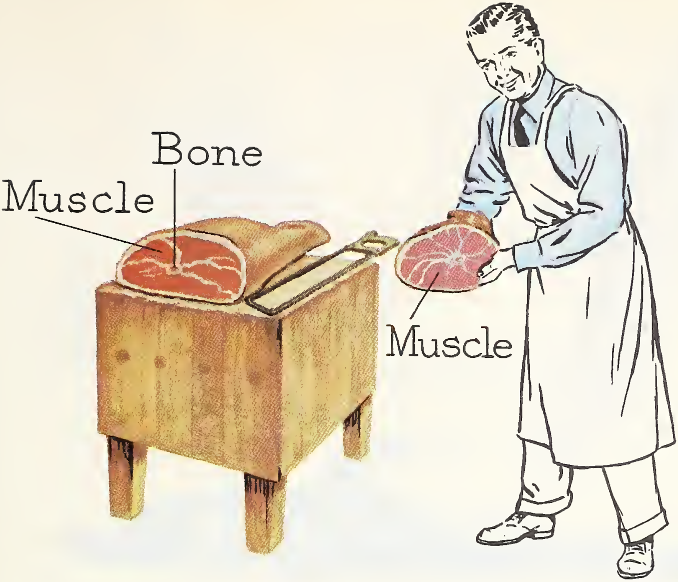
How We Move

Muscles and Tendons

A part of your arm swells when you lift something heavy. The part that swells is called your muscle.

Lift a heavy book. Can you feel your muscle swell? Feel your leg muscles swell as you walk. Stand on tiptoe. Can you feel muscles in your lower legs swell?





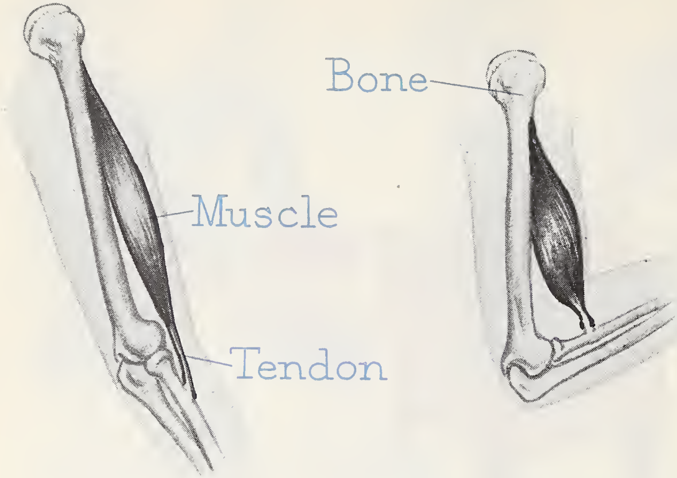
Animals have muscles too.

We eat the muscles of animals when we eat lean meat.

Beefsteaks are cut from the legs of cattle. A ham is the leg of a pig. A drumstick is the leg of a turkey.

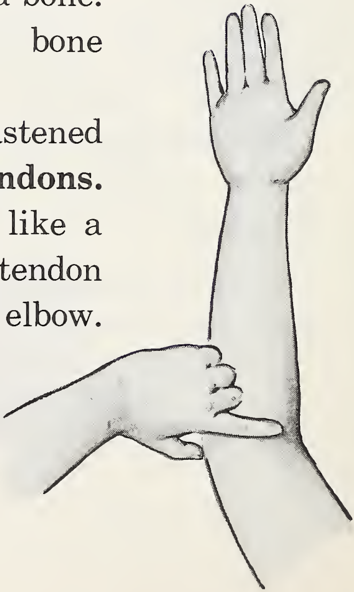
Look at some meat. Find the bone. Find the muscles.

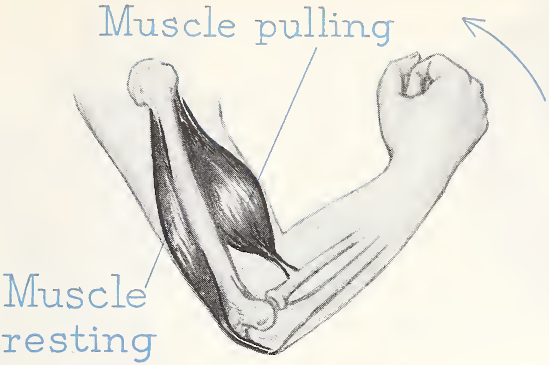
Turkey leg



Muscles are fastened to your bones. Whenever a muscle swells, it is pulling on a bone. The pull makes the bone move.

Some muscles are fastened to the bones with **tendons.** A tendon is something like a cord. You can feel a tendon in the hollow of your elbow.

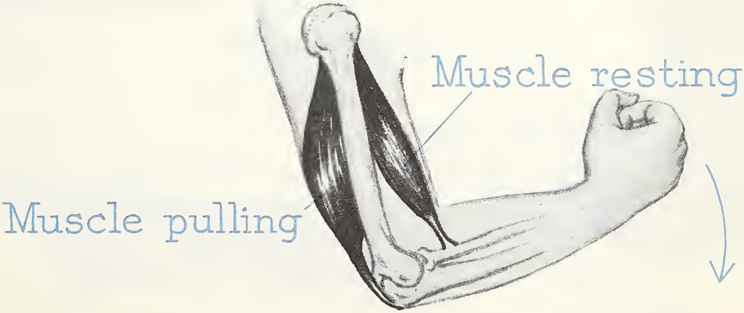


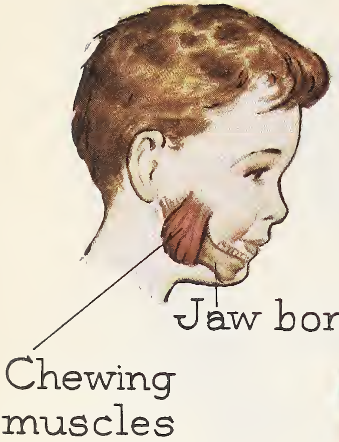


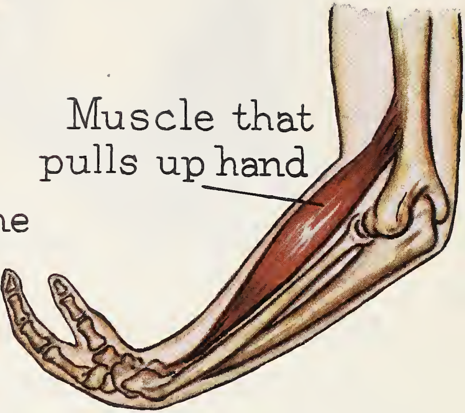
Muscles make your body move.

Look at the picture at the top of the page. Find the muscle that pulls the lower arm upward.

There is another muscle that pulls the lower arm down. You can feel this muscle in the back of your upper arm. Press the back of your hand against a table top while you feel this muscle.

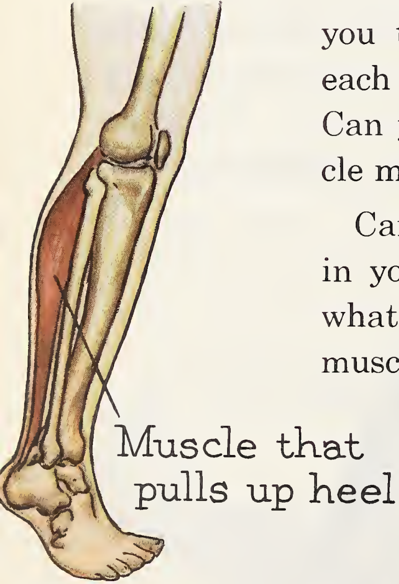






Here are more muscles for you to study. Can you find each one in your own body? Can you find what each muscle moves?

Can you find other muscles in your body? Can you find what part of your body each muscle moves?



Wrist tendons

Neck tendon

Can you find these tendons in your own body? Try to find out what each tendon moves. Can you find the muscles that pull on the tendons?

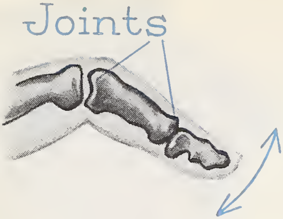
The tendons that move your fingers are long. They are connected with the muscles in your lower arms.

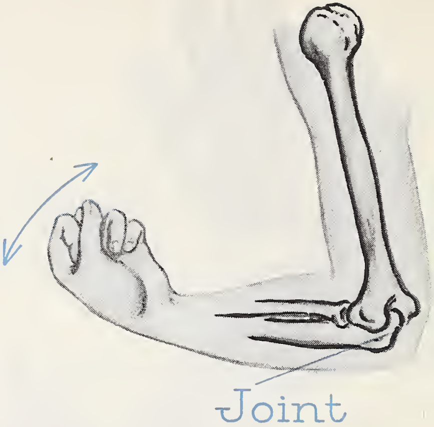
There are tendons that bend the fingers and there are also tendons that straighten your fingers. Can you find them?

Knee tendons

Heel tendon

Hand tendon



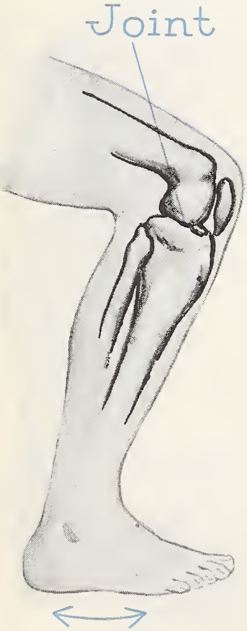


Joints

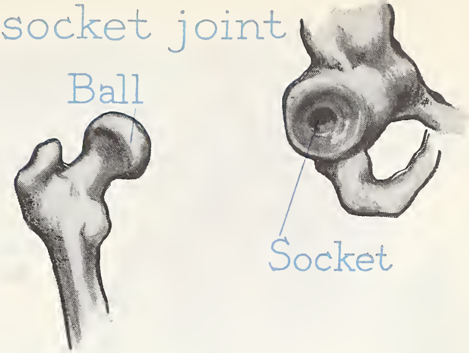
The places where parts of our bodies bend are called **joints.**

Some of the joints bend like hinges. These pictures show some of the hinge joints in your body. Find each one and see how it bends.

Can you find other hinge joints in your body?

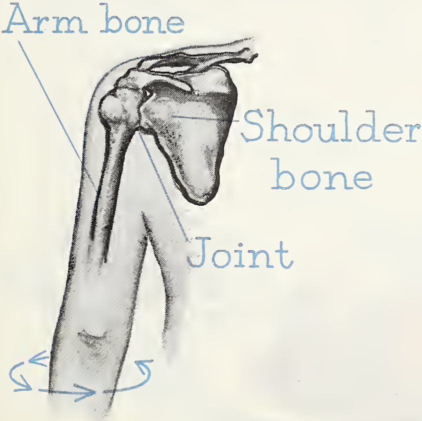


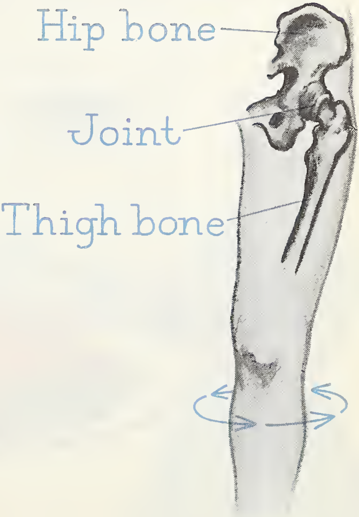
Ball-and-socket joint



There is a different kind of joint in the shoulders and hips. There is a ball on one bone that fits into a hollow in another bone. The hollow is called a socket.

A ball-and-socket joint lets an arm or a leg swing in circles. Show how you can swing an arm or a leg in circles.

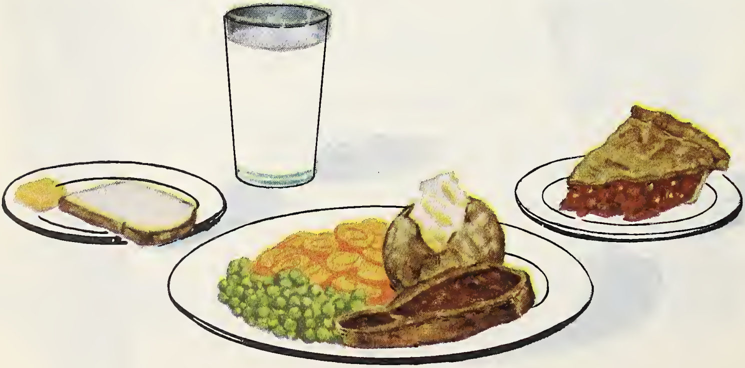


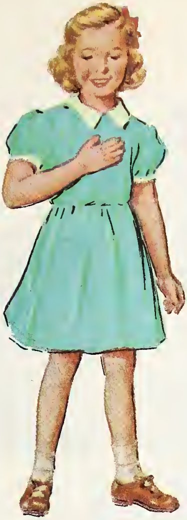


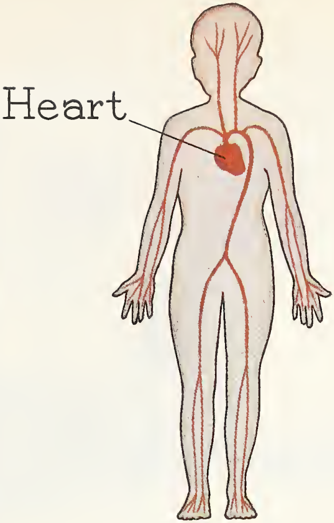
Energy for Muscles

This boy is using his muscles as he rides his bicycle. He needs energy to move the bicycle. His muscles must have energy.

His energy comes from his food. The food he eats dissolves and goes into his blood.

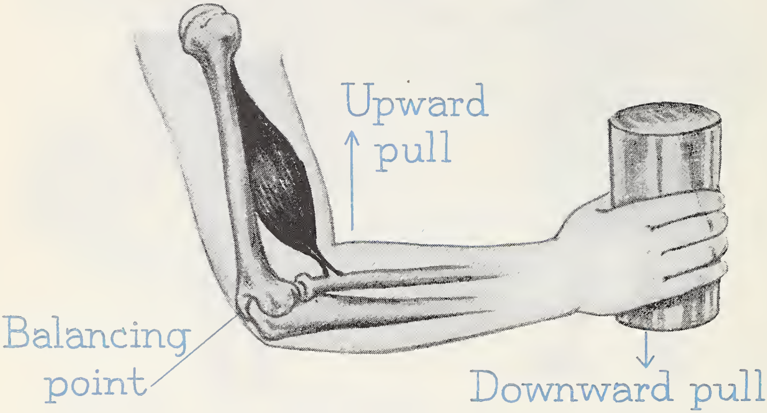






Blood carries the dissolved food to the muscles. The food gives the muscles the energy they need to move. Put your hand on your chest. You can feel your heart pumping blood through your body.

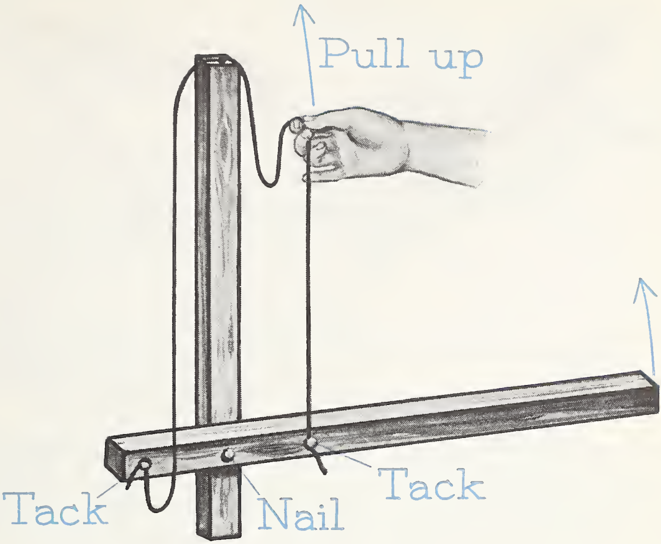
When you are exercising, you need more energy. Your heart beats faster and your blood carries more food to your muscles.



Levers in Our Bodies

Your arm is a lever. Hold something in your hand and lift it. The muscle in your upper arm pulls up on the bone in your lower arm. Your lower arm turns on the hinge joint in your elbow. Your elbow joint is the balancing point of the lever.

There are many other levers in your body. Find some of them and find the balancing points.

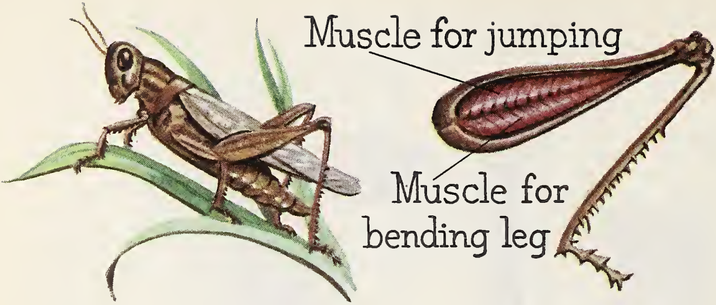


Here is a model that will show you how the lever in your arm works.

Nail two sticks together as shown. One stick will be the upper arm bone. The other stick will be one of the lower arm bones. The nail will be the elbow joint.

Fasten two strings to the lower stick with thumbtacks. These strings will be the muscles in the upper arm.

Pull one of the strings. What happens? Pull the other string. What happens?



Some animals have muscles but no bones. A grasshopper is one of these animals.

A grasshopper has a hard covering all around its body parts. It has muscles inside the hard covering. The muscles are fastened to the inside of the covering.

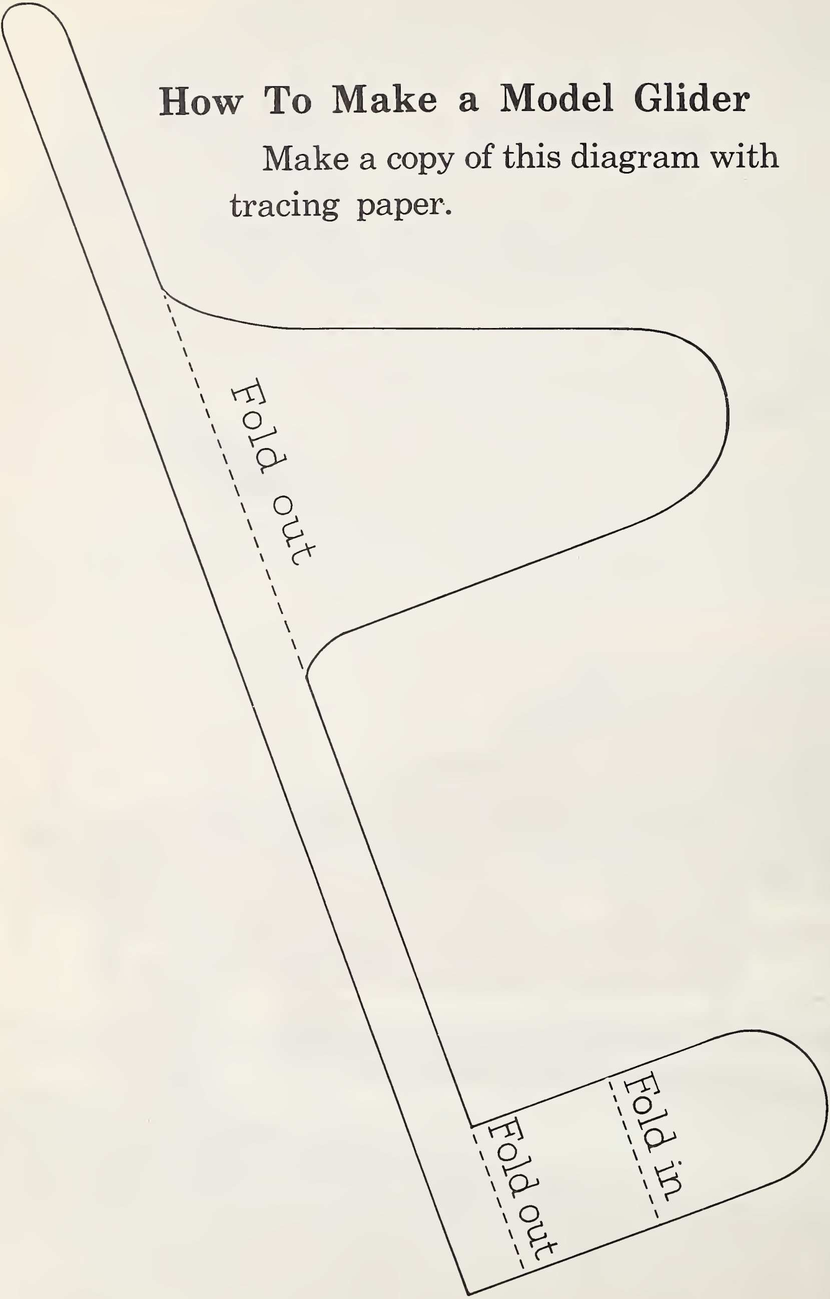
---

1. What do muscles do?
2. Where are the muscles that move your lower arm?
3. What kind of a joint do you have in your elbow?
4. What kind of a joint do you have in your hip?
5. How do you get energy to move your body?
6. What tendons can you find in your leg?
7. What is lean meat?

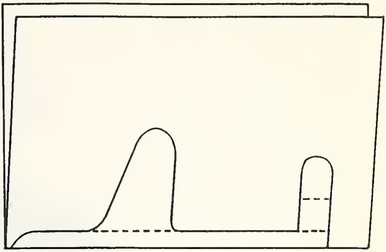
Airplanes

How To Make a Model Glider

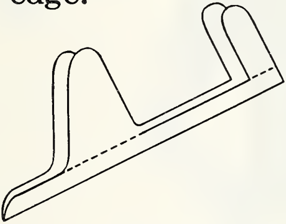
Make a copy of this diagram with tracing paper.



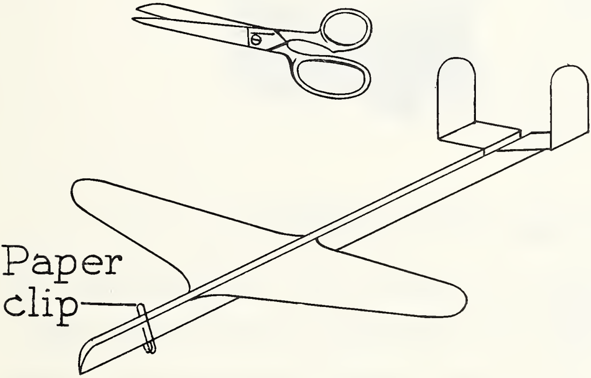
Fold a piece of thin cardboard and trace the diagram on it.



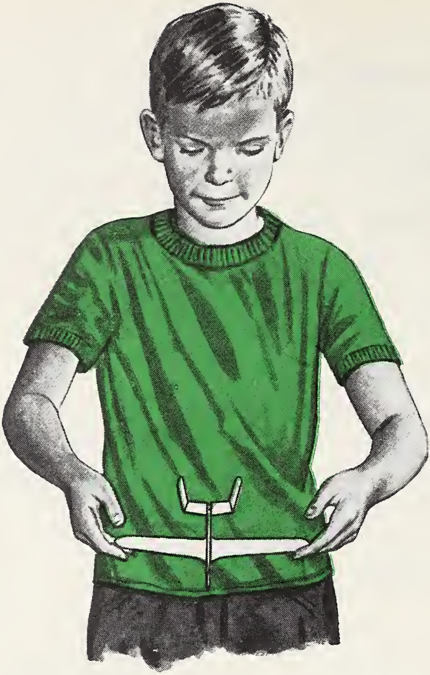
Place the straight line on the folded edge.



Use scissors to cut along the traced line.



Bend the wings and tail as shown. The finished glider should look like this.

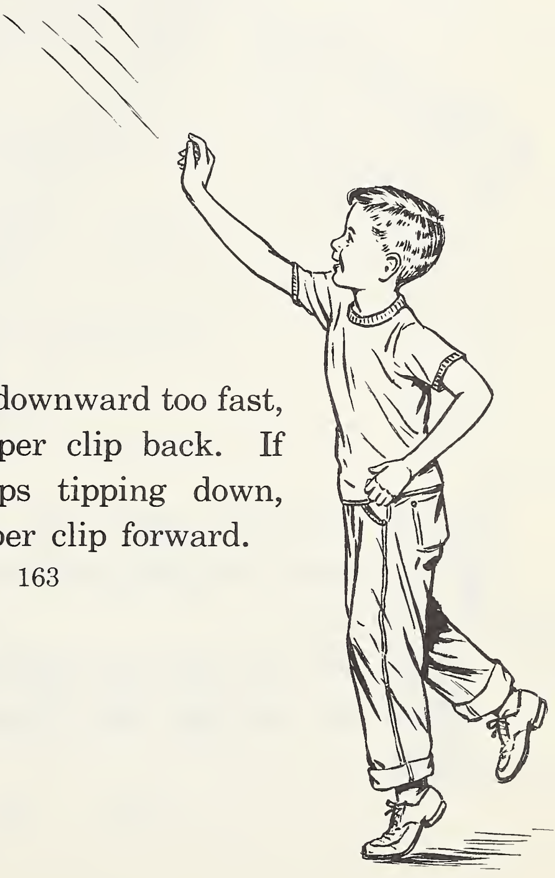


Balancing and Testing

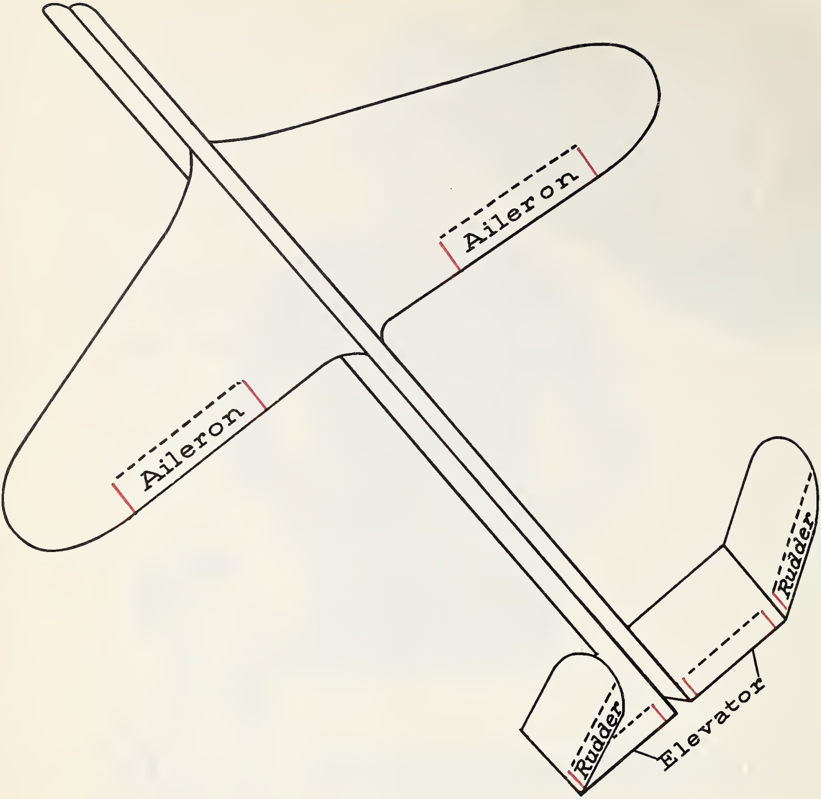
An airplane needs to be well-balanced. If one end is too heavy, it will not fly well.

A glider must be well-balanced too. Rest the ends of the wings on your fingers. If the nose tips down, move the paper clip back. If the tail tips down, move the paper clip forward.

Throw your glider upward. It should glide in a straight line.



If it glides downward too fast, move the paper clip back. If the tail keeps tipping down, move the paper clip forward.



After you have tested your glider, make small cuts at the places marked with red in this picture.

You can now make the glider do different things by bending the controls marked above.

Try each of the following and find out what your glider does:

1. Bend both rudders right.

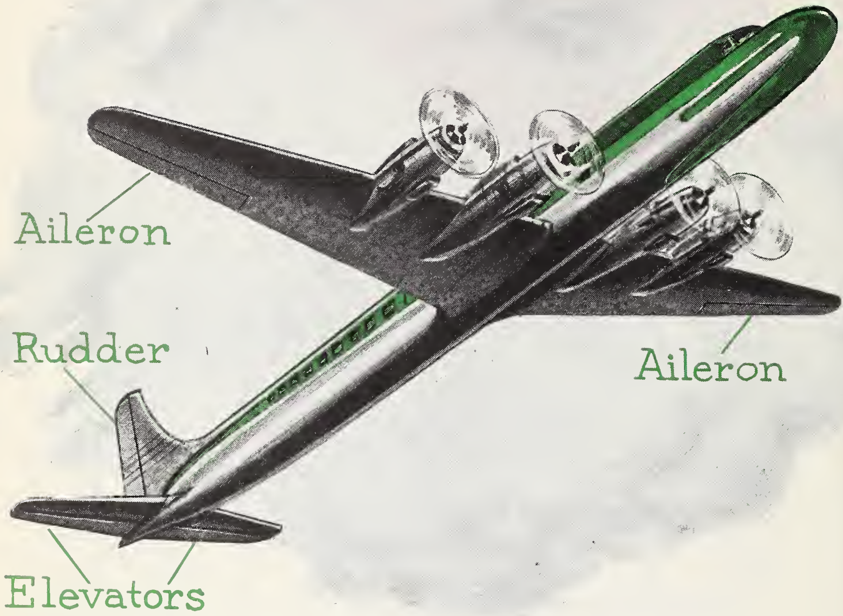
2. Bend both rudders left.

3. Bend both elevators up.

4. Bend both elevators down.

5. Bend the right aileron up and the left aileron down.

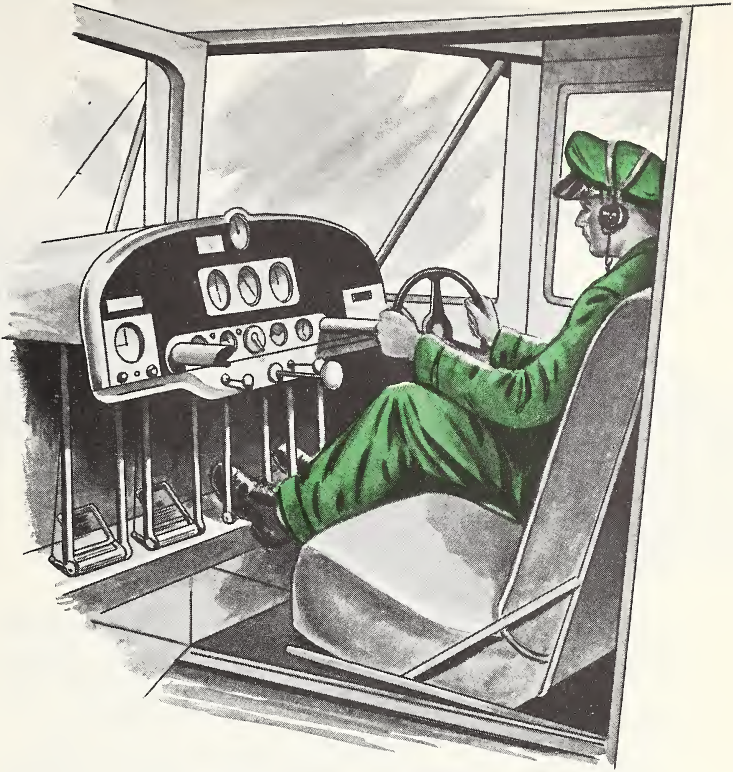
6. Bend the right aileron down and the left aileron up.



How Airplanes Are Controlled

Airplanes have the same controls that your gliders have. The elevators make the airplane head up or down. The rudder steers it. The ailerons tip the wings up or down.

Visit an airport and look for these controls on an airplane.



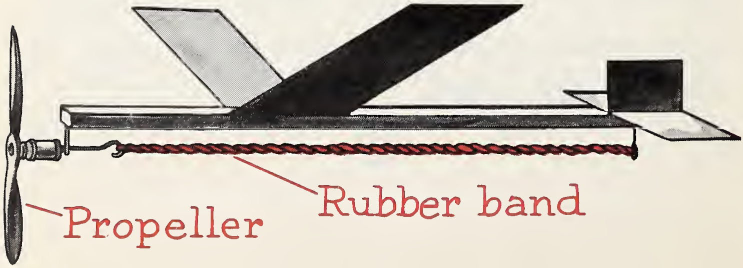
A pilot controls an airplane by using his hands and feet. He steers the airplane with his feet by pushing the rudder pedals.

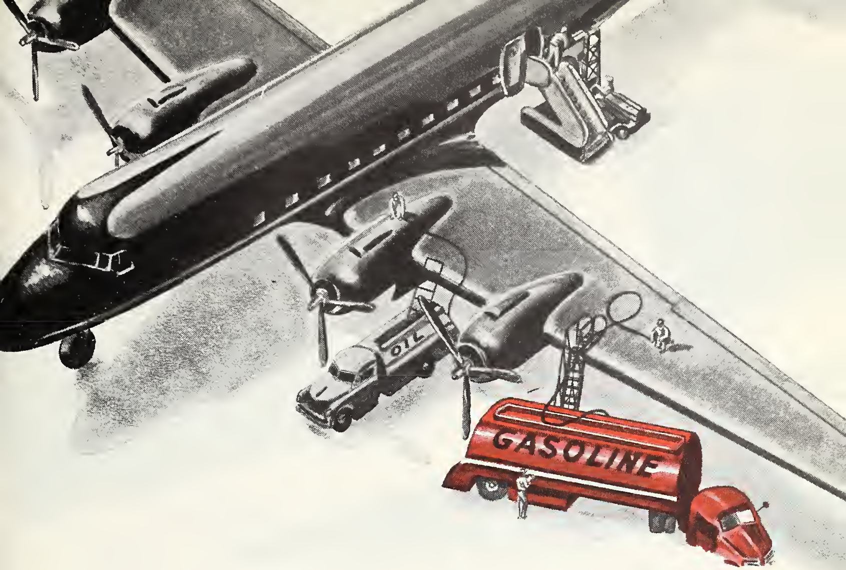
He makes the airplane climb or dive by pulling or pushing the wheel. He makes the airplane bank to one side or the other by turning the wheel.

Energy for Airplanes

Many model airplanes have rubber-band motors. Perhaps someone who makes model airplanes will show you how one flies.

First he turns the propeller backwards to twist the rubber band. This gives the rubber band energy. Then he lets the airplane go. The energy in the rubber band spins the propeller and moves the airplane through the air.

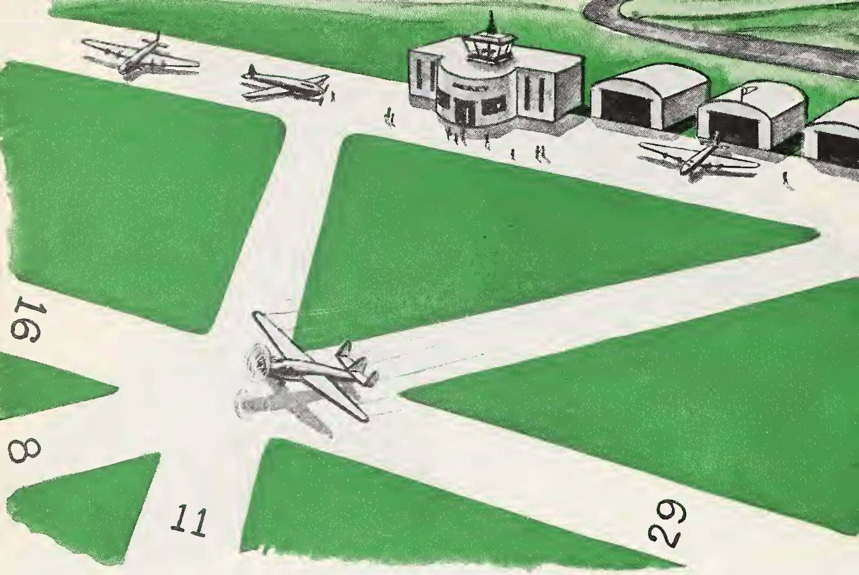




Big airplanes need energy too. They use the energy stored in gasoline.

Most airplanes have gasoline tanks in the wings. You will see men filling the tanks when you visit an airport.

The energy in the gasoline makes the engines turn. They make the propellers spin. The propellers move the airplane through the air.



Wind and Airplanes

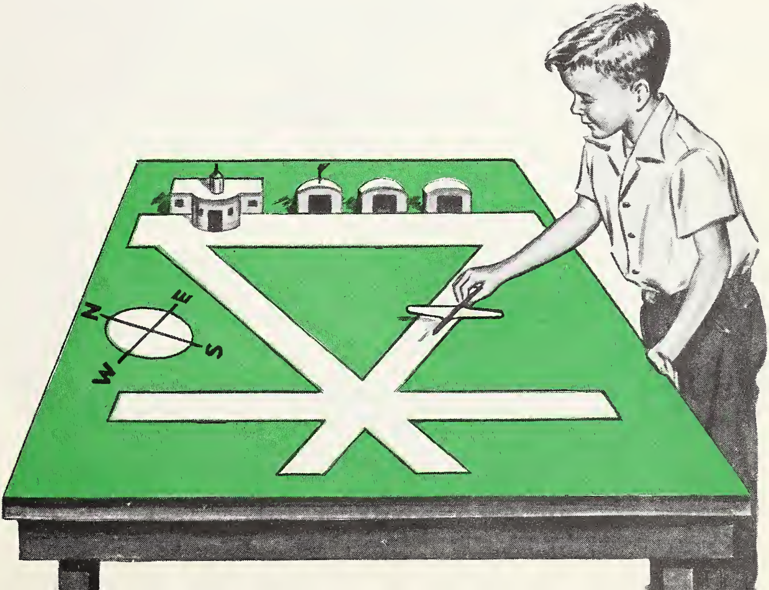
Airports usually have several landing strips that run in different directions. Pilots use one strip when the wind is from the west, and they use a different strip when the wind is from the south.

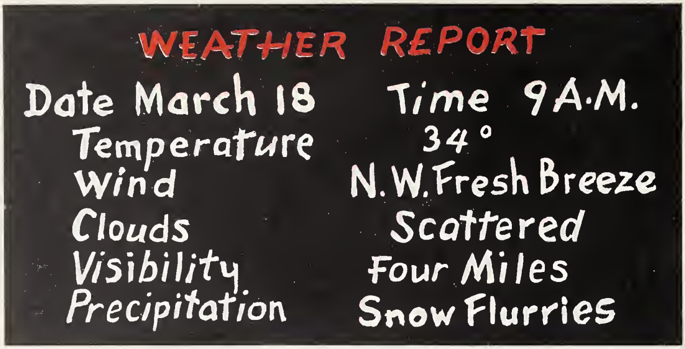
It is easier for planes to land and take off if they head into the wind. If the wind is from the west, the pilot will head his plane toward the west. The pilot will head his plane toward the south when the wind is from the south.

Some fourth-grade pupils visited an airport. Then they made a model airport. Perhaps you would like to make one too.

They used a large sheet of cardboard for the airport. They marked out the landing strips. They used cardboard boxes for the buildings. They used a compass to find directions.

Then they learned to use the landing strips. They chose the strips that let them head into the wind when they landed and took off in their model airplanes.





WEATHER REPORT

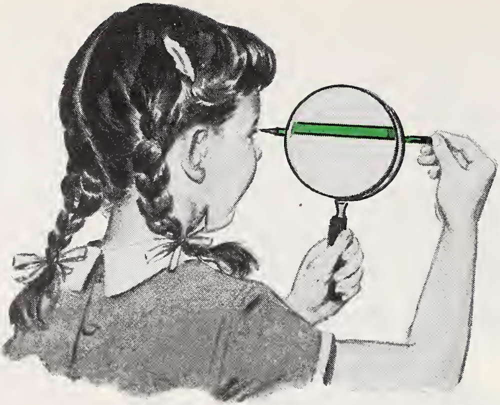
Date March 18	Time 9 A.M.
Temperature	34°
Wind	N.W. Fresh Breeze
Clouds	Scattered
Visibility	Four Miles
Precipitation	Snow Flurries

The class also kept a record of the weather. Some days were good flying weather. On other days they would not let the planes take off. Can you tell why?

---

1. How can you tell when a glider is well-balanced?
2. Why are the landing strips at airports usually laid out in different directions?
3. What is the rudder of an airplane used for?
4. How does a pilot make the ailerons move?
5. Why is weather important to a pilot?
6. Where do airplanes get the energy that makes them move?
7. What part of a plane makes it head upward or downward?

A Hand Lens

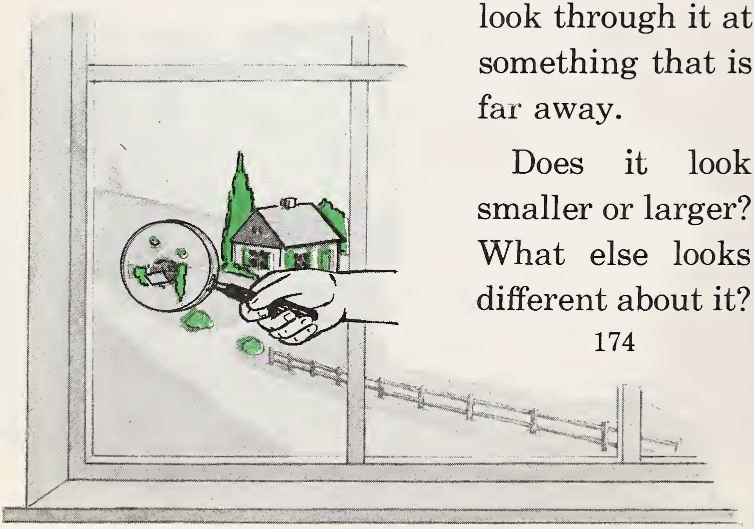


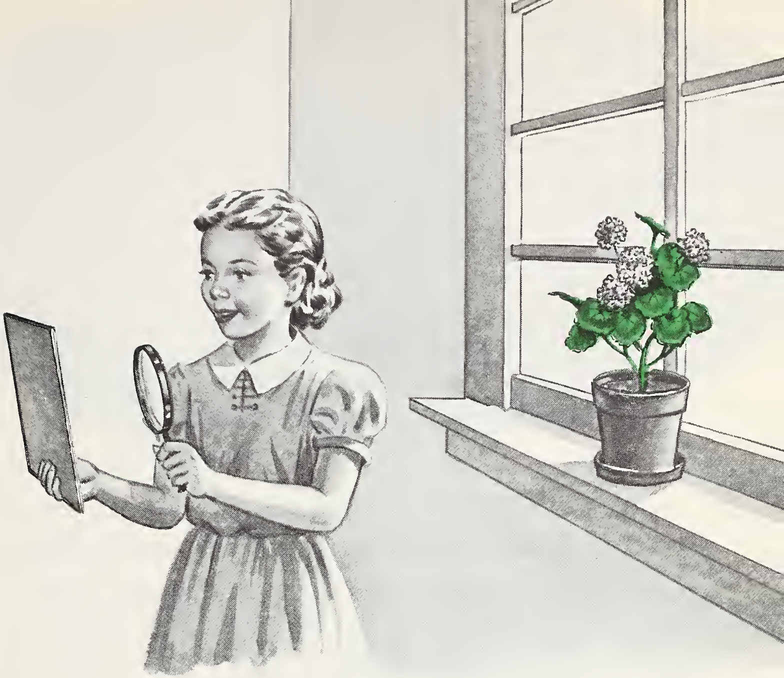
What a Lens Can Do

Look at a pencil through a hand lens. Does the pencil look larger or smaller?

Hold a hand lens as far from your eyes as you can. Then look through it at something that is far away.

Does it look smaller or larger? What else looks different about it?



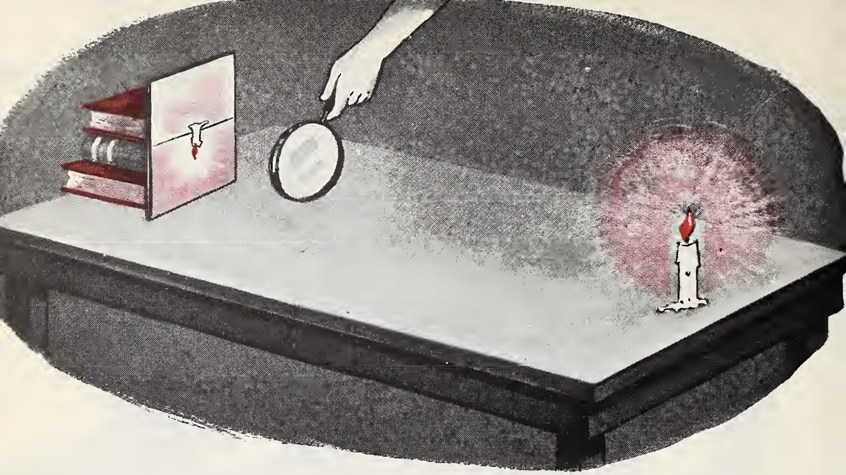


Hold a hand lens between a window and a sheet of white cardboard. Move the lens back and forth until a picture of the window shows on the cardboard.

How does the picture look? Is it in colour? Is it full size? Is it right side up?

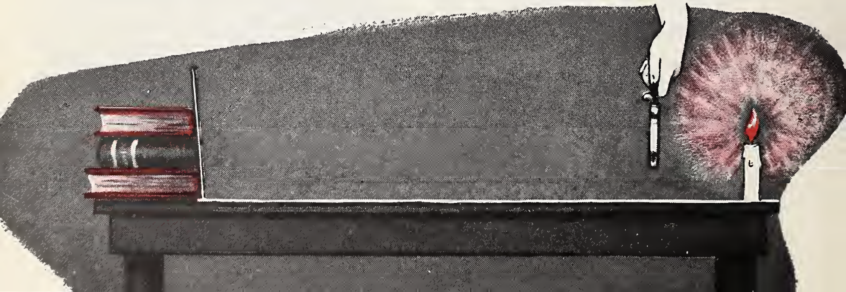
Ask someone to stand before the window and wave his arms.

The picture will show better if the shades on the other windows are down.



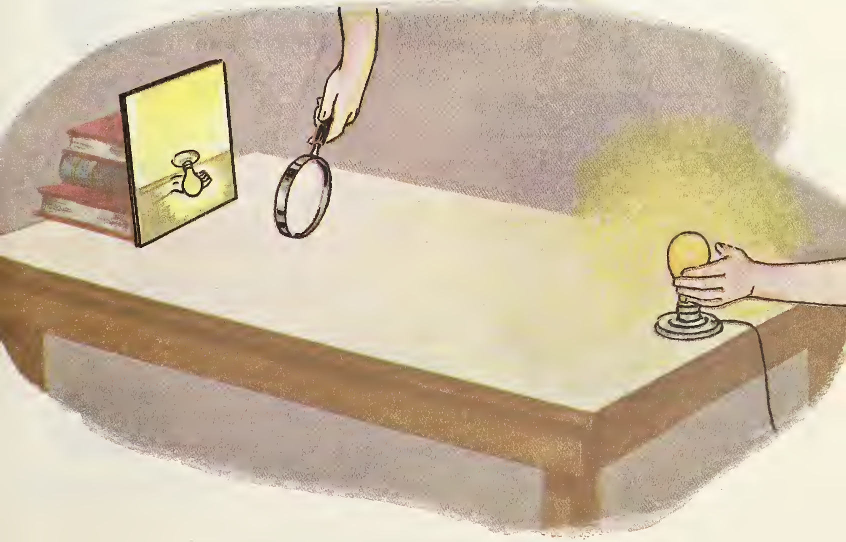
Make the room as dark as you can for this experiment. Move the lens back and forth in front of the cardboard until a picture of the candle shows on the cardboard. If you cannot make a picture, perhaps the candle is too close to the cardboard.

Move the lens back and forth near the candle until a picture shows. Then move the lens back and forth near the cardboard until a picture shows. Which picture is larger?



Move the candle and the cardboard farther apart. Move the lens until there is a picture of the candle on the cardboard. What has happened to the picture?

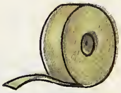
Use an electric lamp in place of the candle. Can you make a picture of the lamp? Put your hand behind the lamp. Can you see a picture of your hand?



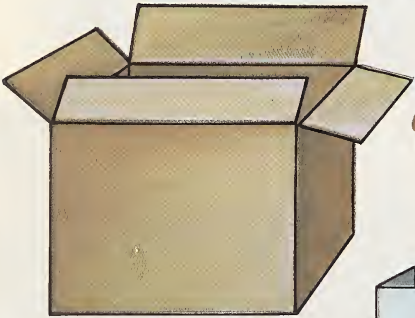
Putting on a Picture Show

Would you like to put on a picture show? You will need a room that can be made dark and the things shown below.

Hand lens



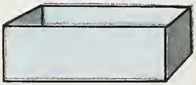
Tape



Cardboard carton

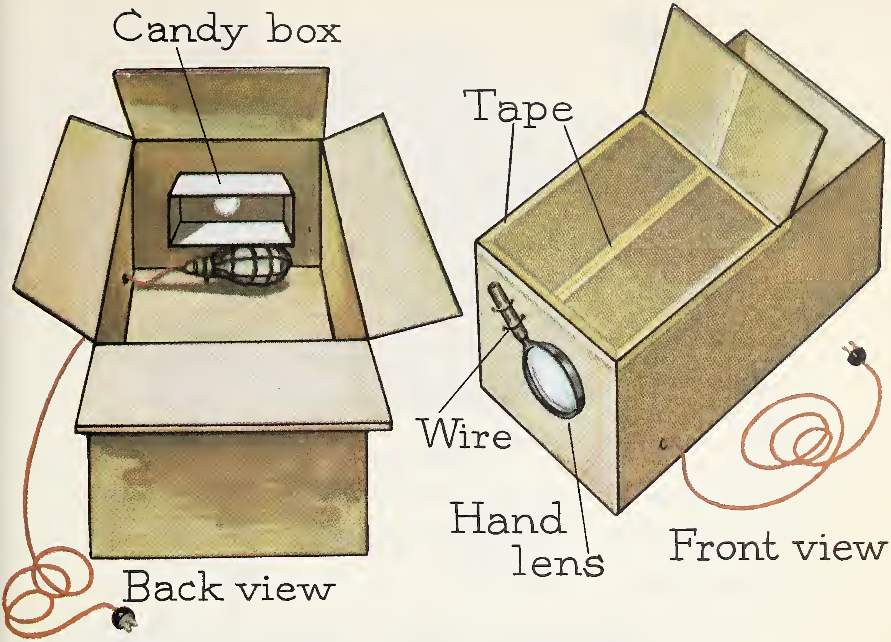
Lamp cord

Wire



Candy box

Lamp guard



Back view

Front view

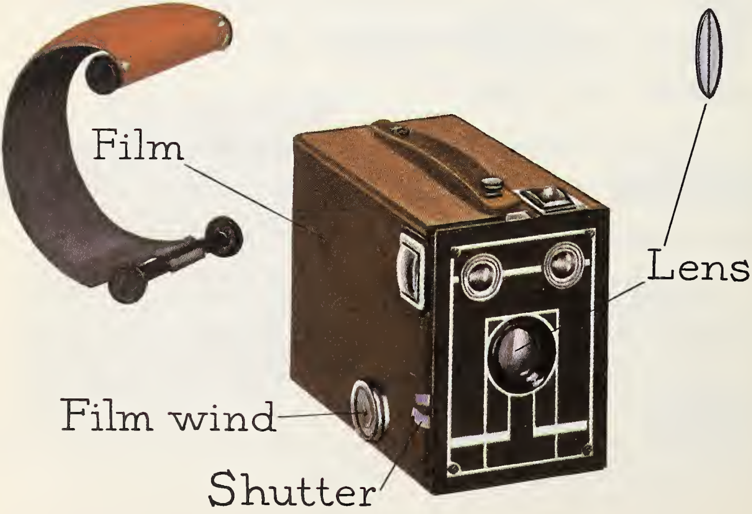
Cut round holes in the carton and in the candy box as shown in the picture. Each hole should be a little smaller than the lens. Fasten the candy box and the lens to the carton with wire.

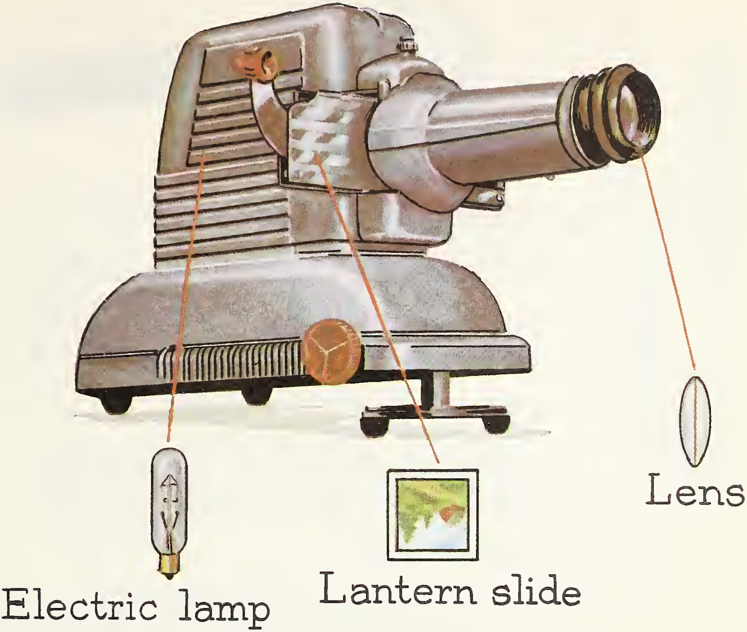
Make a small hole in the carton and put the lamp cord through it. Cut off the cover of the carton and tape it together as shown.

Hold a picture in the back of the box. Move it back and forth until the picture shows on the wall.

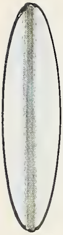
There is a lens in a camera. Light goes through the lens and makes a picture on the film.

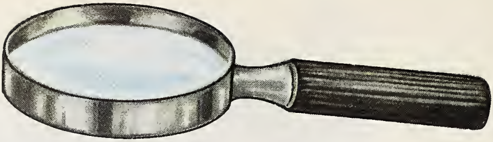
Ask someone to bring a camera to school. Look at the parts.





Here is another way that a lens is used to make a picture. Do you know why the lantern slides are put in upside down?



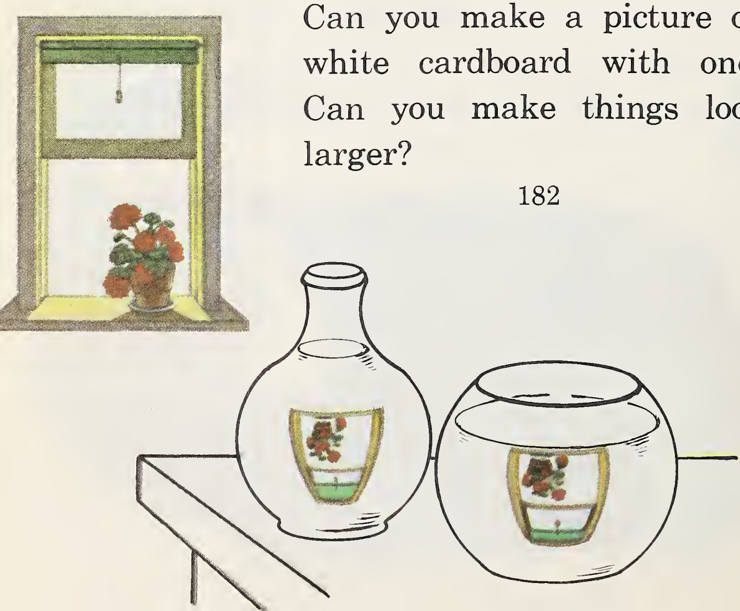


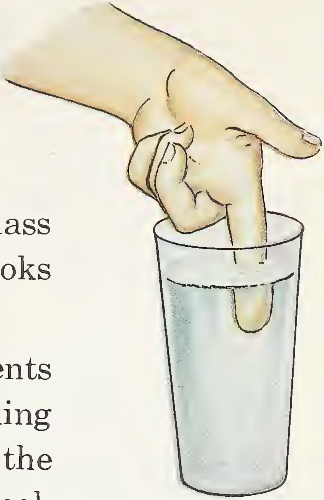
The Shape of a Hand Lens

A hand lens is thick in the middle and thin at the edges. Feel the glass with your fingers to find out where it is thick and where it is thin.

Any piece of glass that is thicker in the middle than at the edges will act like a hand lens.

A round glass bowl full of water will act like a hand lens. Can you make a picture on white cardboard with one? Can you make things look larger?

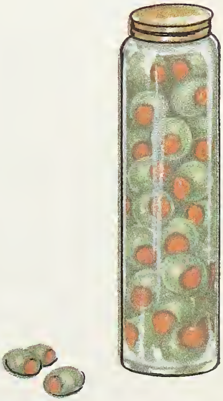


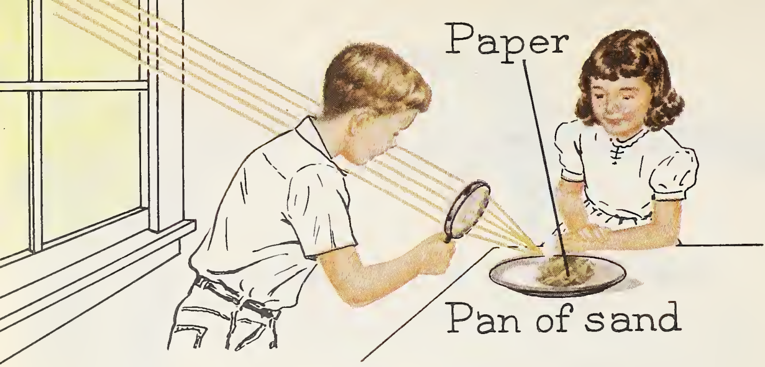


Anything in a round glass jar or bowl of water looks larger than it is.

Make up some experiments with glass bowls and drinking glasses full of water. Do the things inside always look larger?

Does something inside a bowl look larger if there is no water inside?





Fire with a Hand Lens

A hand lens can bend sunlight toward one point. The energy of the sunlight makes this point very hot.

Try to set paper on fire with a large hand lens. Put the paper in a pan of sand. What else should you do so that this experiment will be safe?

---

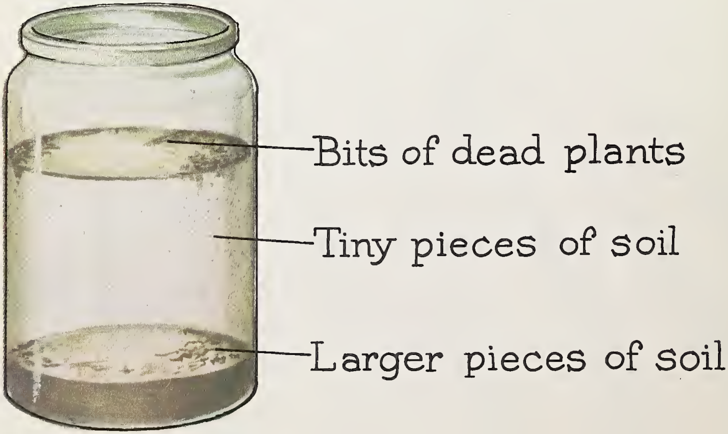
1. What is the shape of a hand lens?
2. What things can a hand lens do?
3. What are some things that have lenses in them?
4. How can you start a fire with a hand lens?
5. How can you make a goldfish look larger?

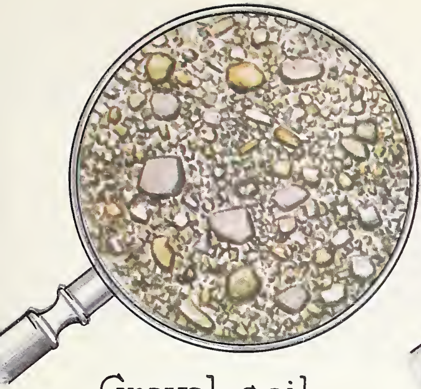
Soil

Kinds of Soil

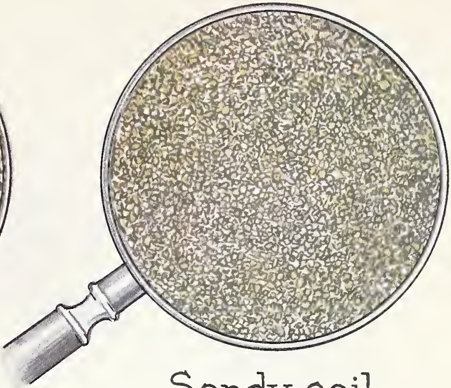
Bring in some garden soil. Stir it in a glass jar of water. Then let it stand.

Are there bits of dead plants in the soil? Are there pebbles and sand? Is there fine soil?





Gravel soil

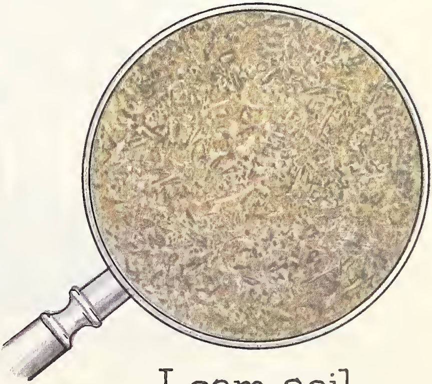


Sandy soil

Soil with pebbles in it is called gravel soil. Sandy soil has much sand in it. Clay soil is very fine. Loam soil has both clay and sand in it. Loam soil often has bits of dead plants in it, too.

Look at different kinds of soil with a hand lens. What kind of soil do you have in your garden? What other kinds of soil can you find?

Clay soil

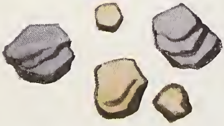


Loam soil

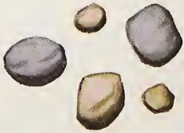
Soil from Rocks

Break a soft rock into small bits. Put the pieces in a bottle that is half full of water. Shake the bottle many times.

Look at the water. What has happened? Take out the pieces of rock. What has happened to them? Can you explain what happened while you were shaking the bottle?



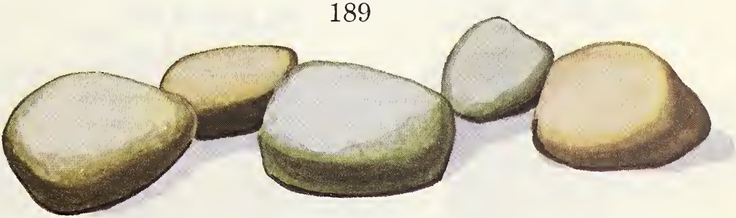
Before shaking



After shaking

The stones in this stream are being rolled and bumped against each other. What happens to the sharp corners of the stones? What happens to the pieces that break off?

If you live near a stream like this one, bring in some stones that are in the water. Do they look like the stones shown below?



Put pieces of soft rock on a large rock. Cover them with heavy cloth. Pound them with a hammer. They will break into tiny pieces.

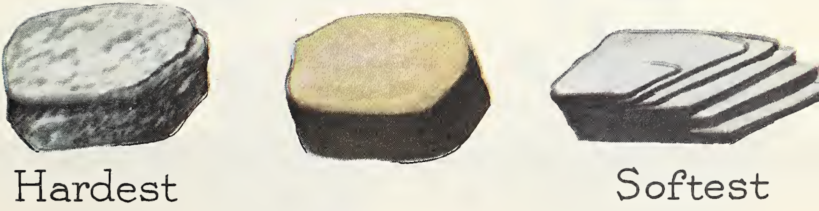
Put the soil you have just made into a small flower pot. Put garden soil in another pot.

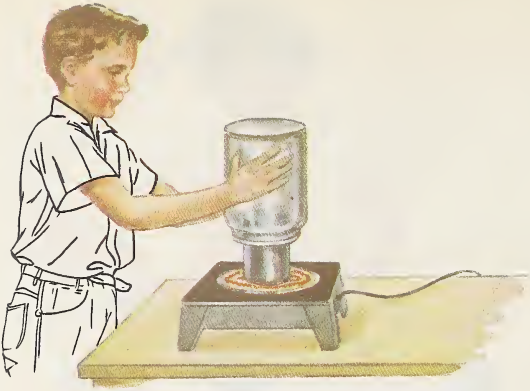
Plant three or four seeds of the same kind in each pot. Keep the soil damp but not wet. Watch the plants for two or three weeks. Which plants grow better?

Some rocks are harder and stronger than others.

Bring in small pieces of different kinds of rocks. Try to scratch one rock with another. Which one seems to be the stronger and harder?

Put your rocks in a row with the hardest rocks at one end and the softest rocks at the other end. Which rocks might become soil more quickly than others?

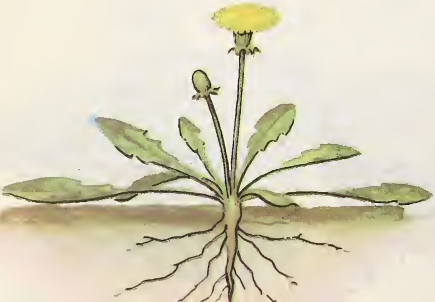


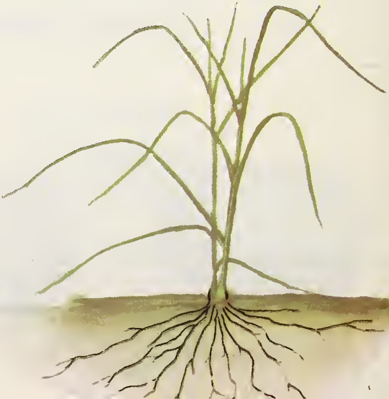


Water in the Soil

Put a handful of soil in a can and heat the can. Hold a glass jar over the soil. What do you see on the glass? If there is water on the glass it must have come from the soil.

Which part of a plant usually takes in water from the soil? There are different kinds of plant roots. Dig up some and see the differences.

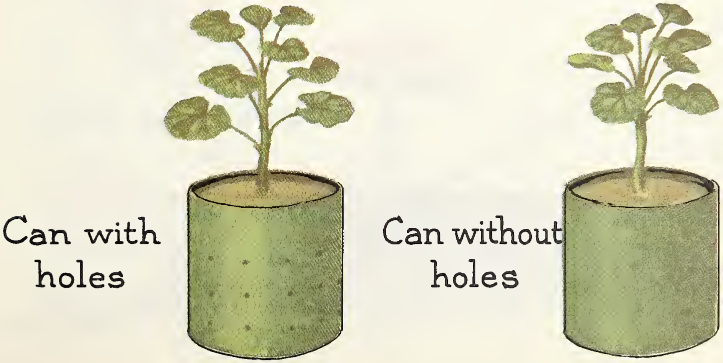




Air in Soil

Put some soil in a glass jar. Pour in some water very carefully. Watch the bubbles of air come from the soil.

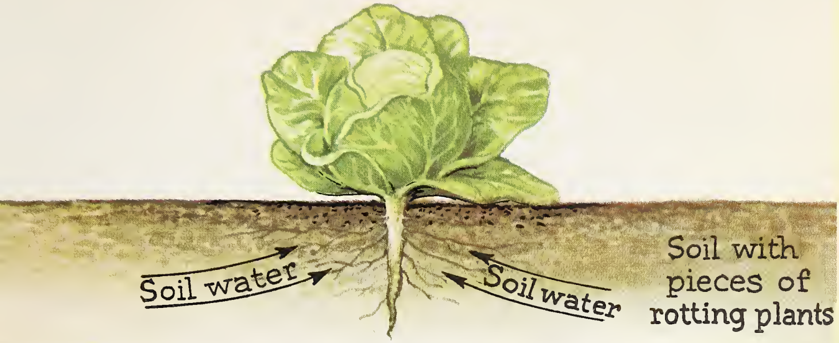
Most plant roots must have air if they are to grow well. Find two small plants of the same kind. Put one in a can that has holes in it. Put the other in a can that does not have any holes. Water both plants well. Which plant grows better? Which plant has more air around its roots?



Dead Plants in the Soil

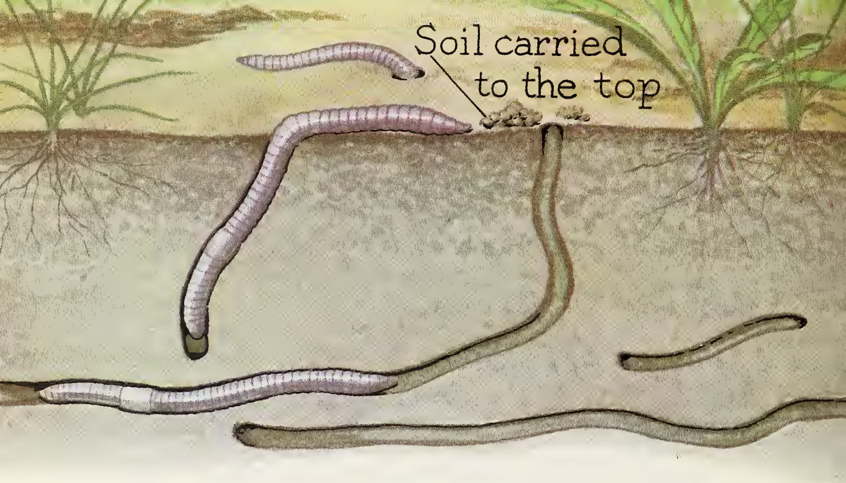
Good soil has bits of dead plants mixed through it. Sometimes there are bits of dead leaves and stems. Sometimes there are bits of dead roots.

Bacteria and other tiny living things rot the dead plants. Mushrooms help rot the dead plants. Rotting changes the dead plants into soil.



Dead plants make good fertilizer. As the plants rot, parts of them dissolve in the water that is in the soil. This water goes into living plants and helps them grow.

Some people burn dead leaves in the fall. Why is it a good idea to let the leaves rot and then put them on gardens?

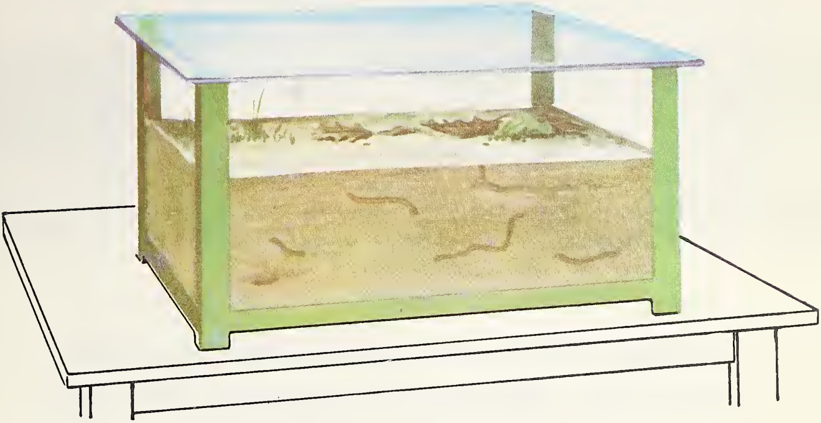

Soil carried to the top

Animals That Live in the Soil

Many animals live in the soil. There are hundreds of earthworms in every garden.

Earthworms make holes in the soil. Water and air go into the holes. Earthworms help keep the soil loose and open.

Earthworms also take soil to the top of the ground. They drag leaves into their holes. They mix the soil and bits of dead plants together.



You can keep earthworms alive indoors. Keep them in cool, damp soil. An aquarium with a glass cover makes a good cage to keep them in.

Put a little corn meal in the soil for the earthworms to eat. They will also eat bits of lettuce and cabbage leaves.

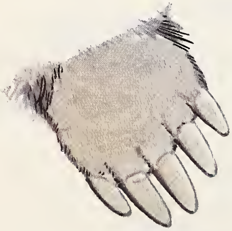
Put some dead leaves and grass on top of the soil. The earthworms may take some of them into the soil.

Mole

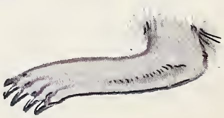
Moles live in the soil. They dig long tunnels as they hunt for earthworms and other small animals.

Moles have short, thick fur that stays clean in the soil. They have very small eyes and cannot see well. The outer parts of their ears are small and do not show. They have long, pointed noses.

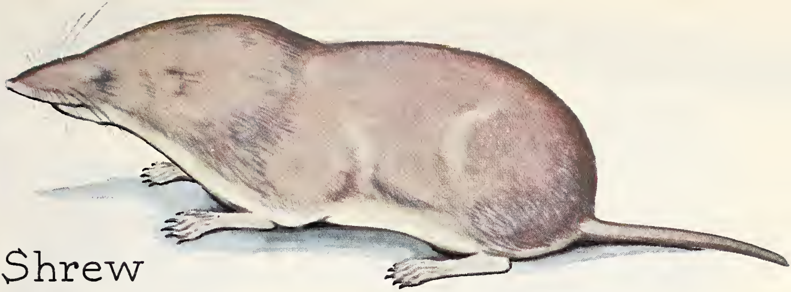
Look at the picture of a mole's front foot. How are such feet helpful to a mole?



Front foot



Hind foot



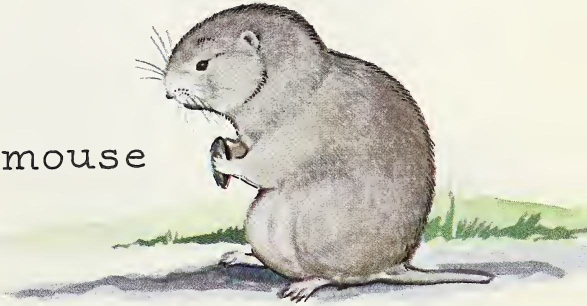
Shrew

Shrews are something like moles. Their eyes are very small. Their outer ears are very small. They have long, pointed noses.

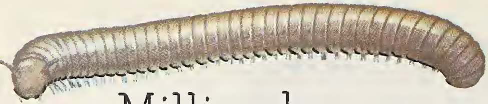
How are the front feet of a shrew different from the front feet of a mole? How are their whiskers different?

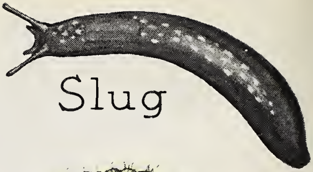
Shrews cannot dig tunnels as well as moles can. They often use the tunnels of moles when they hunt for small animals to eat.

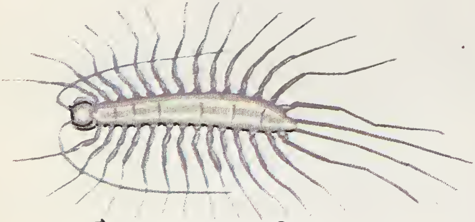
Some people think that moles and shrews are mice. Can you see some ways in which they are different?



Meadow mouse


Millipede


Slug


Centipede

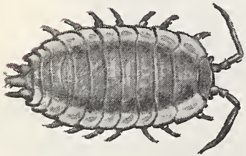
May beetle grub

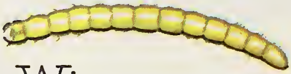
Dig up some garden soil and put it in a pan. What kinds of animals do you find?

Dig up some soil in a woods and other places to see what animals you can find.

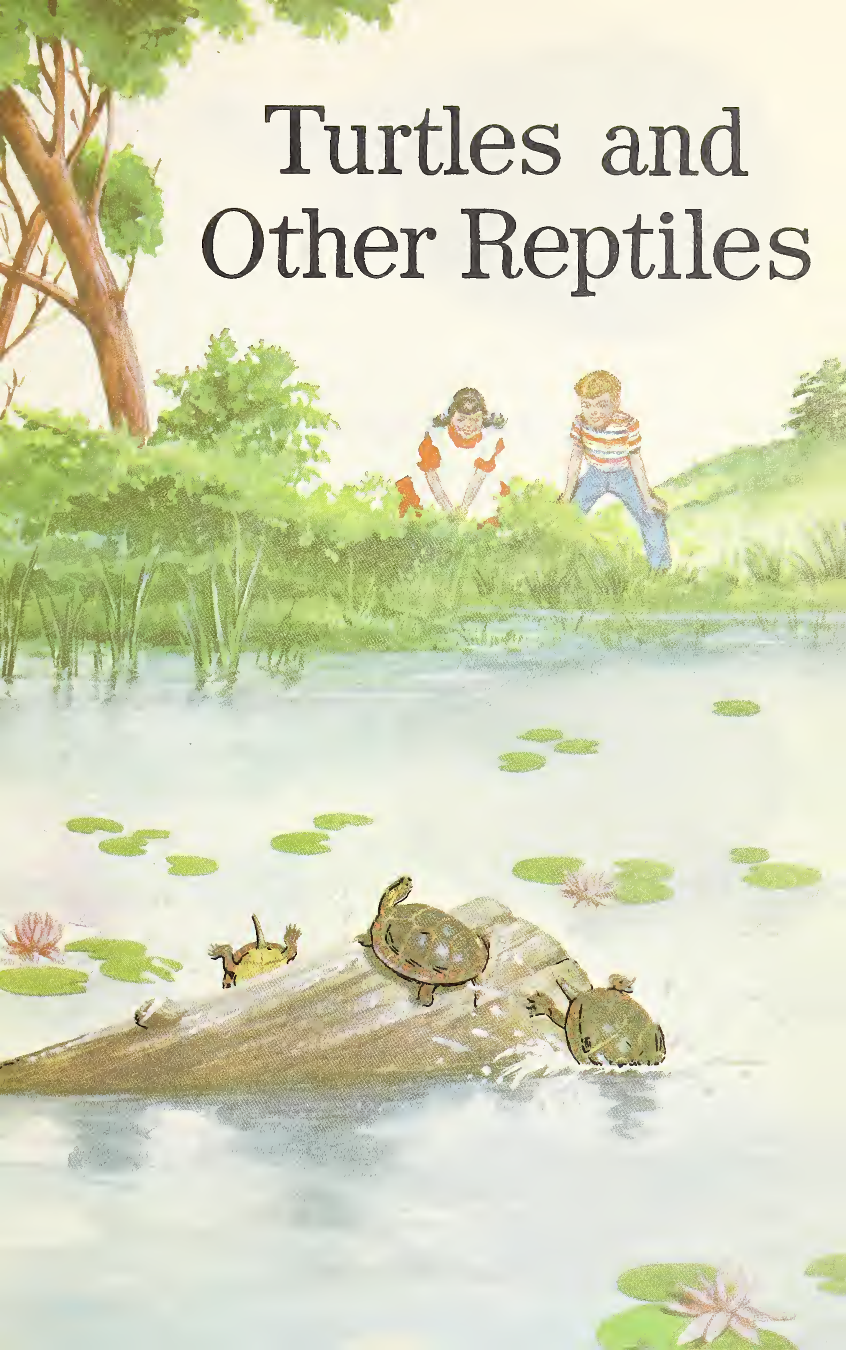
---

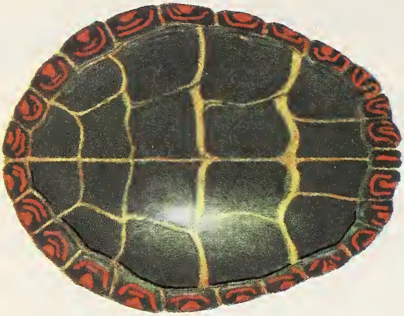
1. Why is soil so important to us?
2. What is soil made from?
3. How do dead things become part of the soil?
4. Name some animals that live in soil.
5. Name some different kinds of soil.
6. Why are dead plants good for the soil?


Sow bug


Wireworm

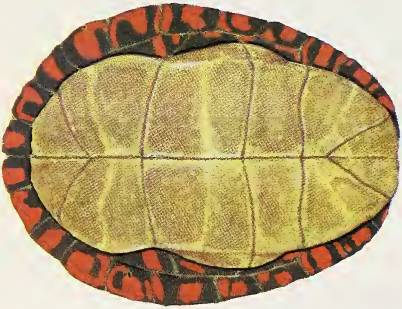
Turtles and Other Reptiles



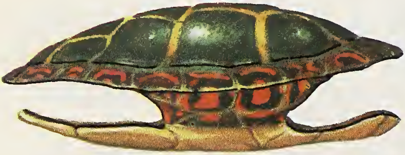


The Turtle's Shell

The turtle's shell is in two parts. There is an upper part and a lower part.



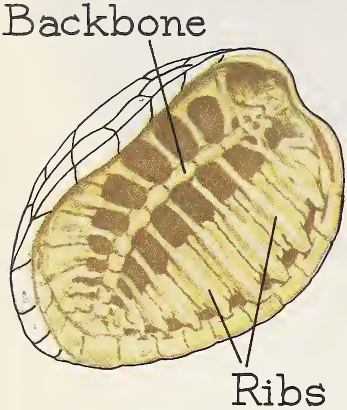
The two parts of the shell are fastened together at the sides.



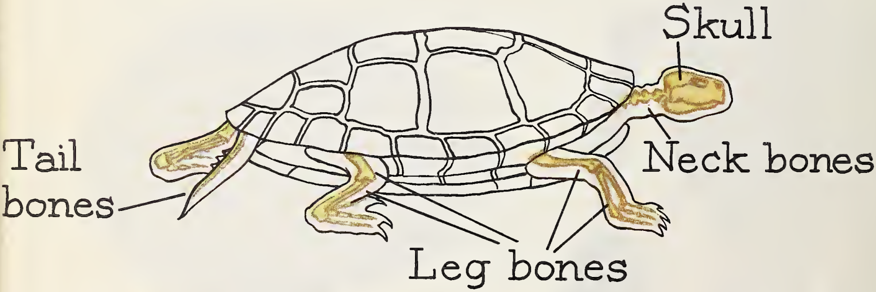
The turtle's head, legs, and tail come out from between the upper and lower parts of the shell.

A frightened turtle will try to dive into the water if it can. If it cannot, it pulls its head, legs, and tail into the shell as far as they can go.

A Turtle's Skeleton



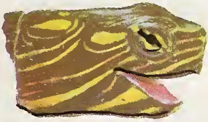
A turtle has bones. The shell is fastened to the ribs and the backbone. Perhaps you can find a turtle's shell for study.



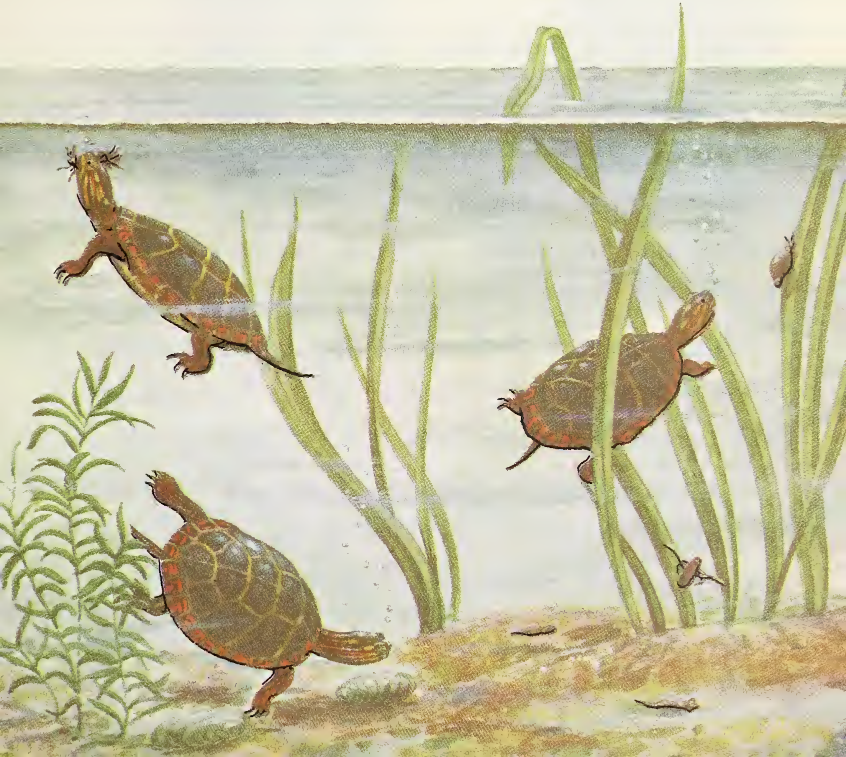
Most turtles have webbed feet. How does this help them? Can you name other animals that have webbed feet?

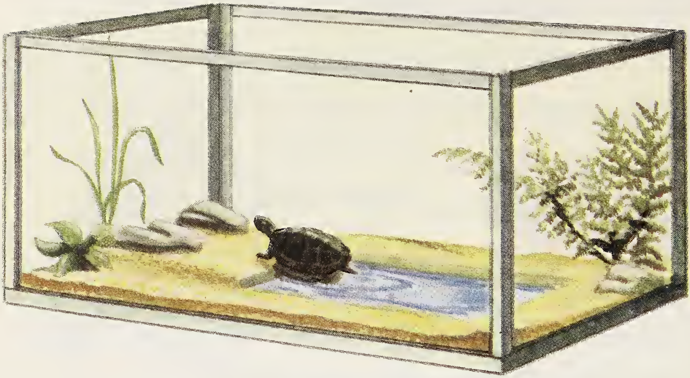
How Turtles Eat

A turtle has no teeth. It has strong, sharp jaws. It can catch animals and bite off pieces of them with these jaws.



Turtles eat insects, snails, small fish, and tadpoles. They eat dead animals, too. Some kinds of turtles also eat plants.





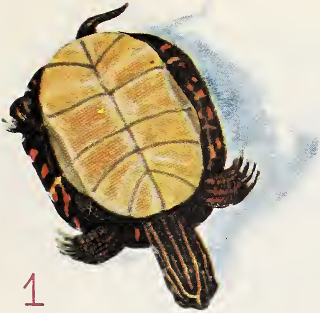
Keeping a Turtle

A turtle makes an interesting pet. Get a small turtle and keep it in a large aquarium.

Nearly all turtles need some water. Some kinds eat in water. These turtles cannot eat in air.

Put a pan in the aquarium and put sand or soil around it. Put a stone in the pan so the turtle can climb out.

Feed the turtle live earthworms and insects. The turtle may also learn to eat tiny pieces of meat.



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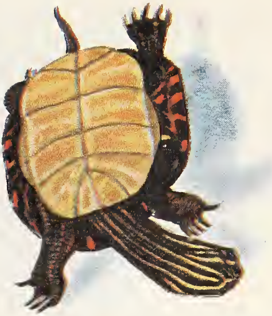

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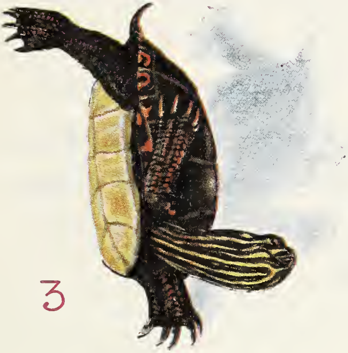

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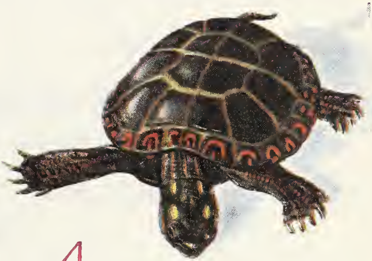


4

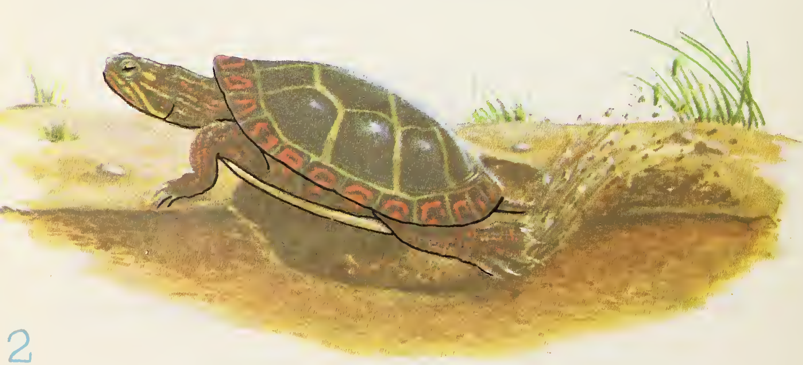
How a Turtle Turns Over

A turtle can turn itself over if it is on its back. Can you find out how a turtle turns itself over? Does it use its legs? Does it use its tail? Does it use its head?

1

Turtle Eggs

In late spring the female turtle looks for a sunny bank of loose soil. She digs a hole with her hind feet.



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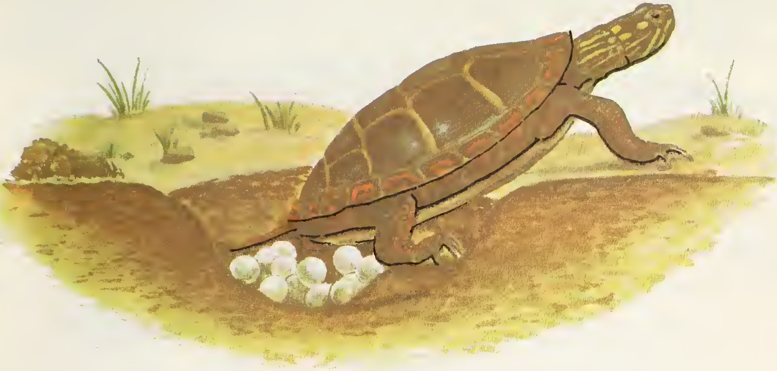
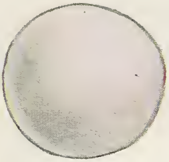
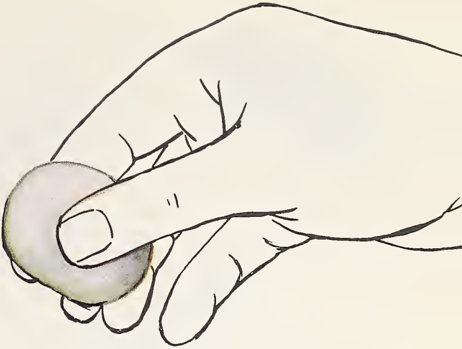


The female turtle lays her eggs in the hole. Then she covers them with the soil she dug from the hole.

The female turtle leaves the sunny bank and goes back to the water. She does not look at the eggs again.

Here are two animals that eat turtles' eggs. No matter how well the eggs are buried, these animals find some of them.

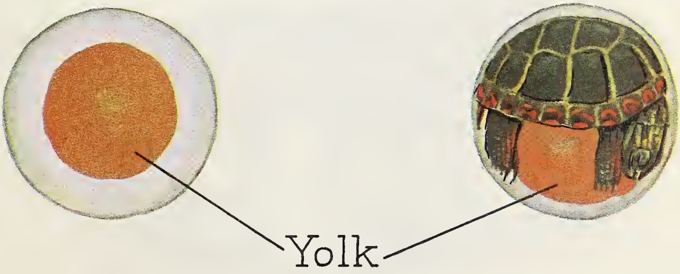


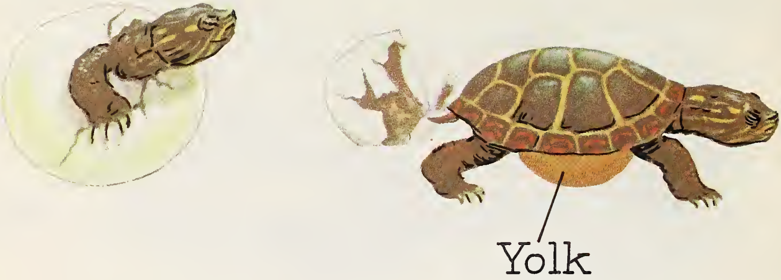


The shell of a turtle's egg is not hard like the shell of a bird's egg. The shell is more like thin leather.

Sunshine warms the soil and keeps the eggs warm. A little spot in each egg begins to grow.

There is a yolk in each egg. The yolk holds food for the growing turtle.





Young Turtles

In three or four weeks a little turtle is ready to leave the egg. It tears a hole in the shell and comes out.

The little turtle is weak. It is not ready to walk or swim. It stays in the soil until it is stronger.

The little turtle still has the yolk on it when it hatches. The turtle uses the food in the yolk while it stays in the soil.

The little turtles dig from the ground when they are strong enough. Then they go to the water.

Many animals eat the little turtles as they go to the water. Foxes, skunks, raccoons, crows, gulls, and hawks find them good food.

As the turtles grow, their shells become harder. Then not many animals can eat them.

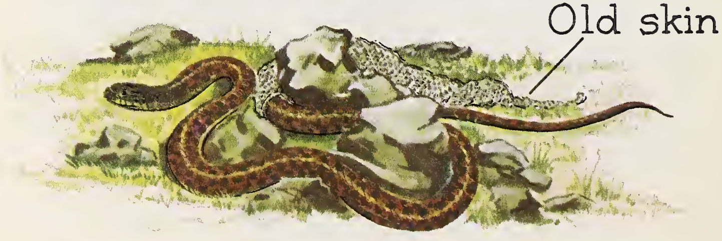
Garter snake

Snakes

Although they do not look much alike, snakes and turtles are both called **reptiles.** In what ways are they different?

A snake is covered with scales but it is not like a fish. Its skin is dry. The skin of a fish is wet and slippery.

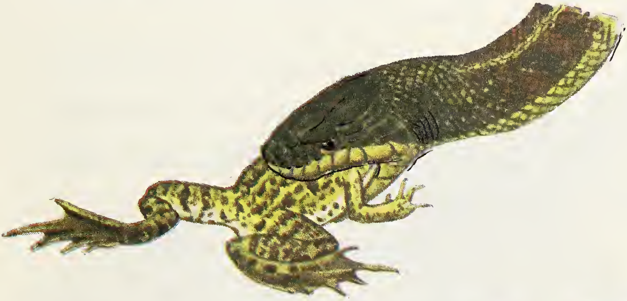
A snake sheds its outer skin in one piece. Sometimes you can find a snake skin in a field where snakes live.

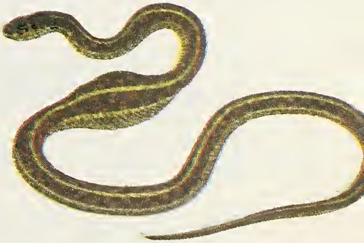


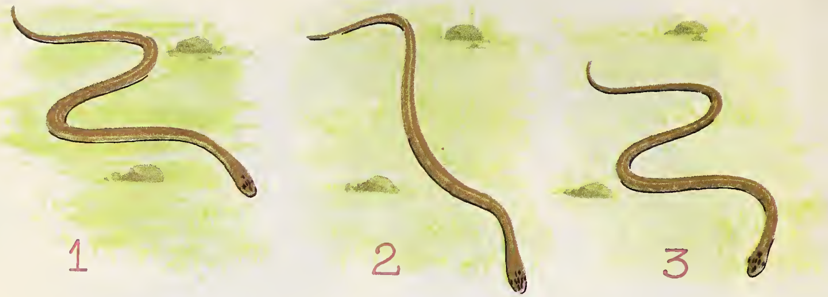
How a Snake Eats

A snake has a long tongue. The snake pushes its tongue out every now and then. Some people believe that the snake smells and tests the air with its tongue. Perhaps it also feels with its tongue.

A snake swallows its food without chewing it. The snake can swallow animals bigger than itself because its jaws can be opened very widely.





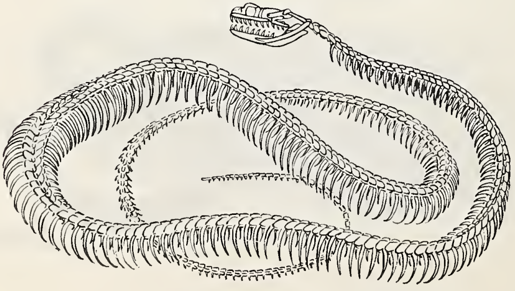


How a Snake Moves

People often wonder how a snake can move over the ground without legs.

First the snake makes a curve in the back part of its body. This curve catches on rough places on the ground, and the snake can then push the front part of its body forward.

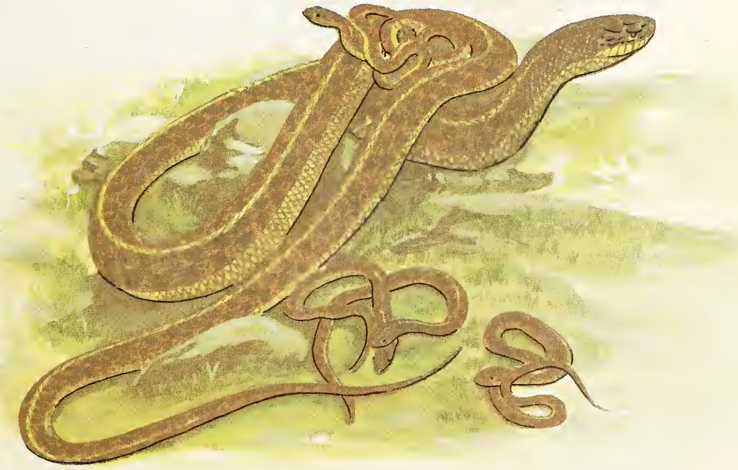
The snake next makes a curve in the front part of its body. It can now pull up the back part of its body. The snake does this over and over. Watch one move.

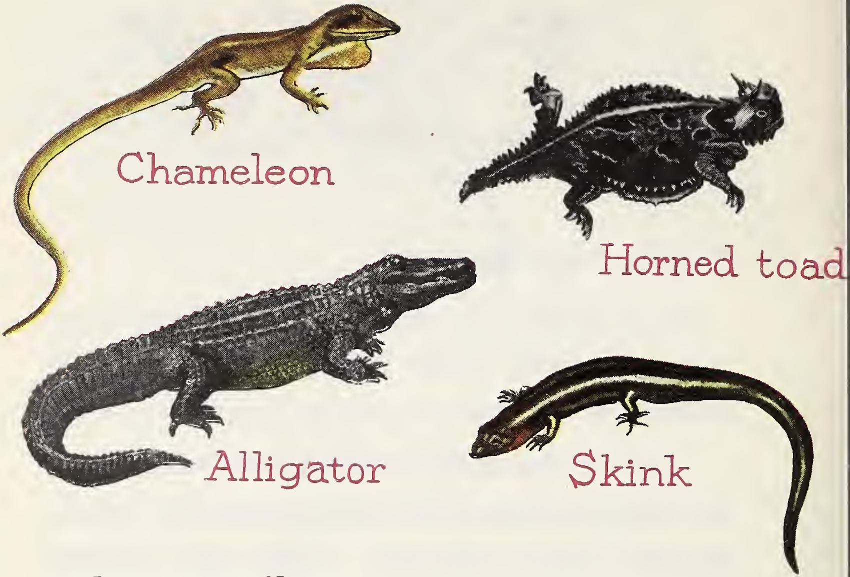


Young Snakes

Some snakes lay eggs. The females bury the eggs and leave them. They do not take care of them.

The females of other kinds of snakes keep the eggs inside their bodies until the eggs become little snakes. Then the young snakes are born alive.





Other Reptiles

Here are four other reptiles. Have you ever seen any of them? What kinds of reptiles live near your home?

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1. What do turtles do when they are frightened?
2. What do turtles eat?
3. Where do turtles lay eggs?
4. What animals eat turtles' eggs?
5. Do snakes have bones?
6. How does a snake move?

The Major Topics Presented in Each Unit

Unit 1 — Night Comes. What happens when night comes. How we get light for night time. What causes day and night.

* **Unit 2 — Insects That Carry Disease.** How houseflies and mosquitoes live. How houseflies and mosquitoes carry disease. How we can protect ourselves from houseflies and mosquitoes.

Unit 3 — Growing Plants Indoors. Some plants we can have in our homes in winter. How we can start plants without seeds. What plants need to grow well.

Unit 4 — Things That Dissolve. Some things that dissolve in water. How we use things that are dissolved in water. How dissolved things are taken from the water.

* **Unit 5 — Stopping Safely.** Why moving things cannot stop at once. Why we should know about stopping distances. Some ways to be safe on streets and highways.

Unit 6 — Birds in Winter. Some birds that spend the winter with us. Where birds get food in winter. How birds stay warm in winter.

Unit 7 — Water in Plants. How plants are different in their need for water. Where water moves in plants. Some things dissolved in the water of plants.

* **Unit 8 — Static Electricity.** How objects can be given an electric charge. What lightning is and what it does. The two kinds of charges and what they do.

Unit 9 — Balancing Forces. How things can be made to balance. How we weigh things. How we use levers.

* **Unit 10 — How We Move.** What muscles are and what they do. How forces act inside our bodies. How we get energy to move our bodies.

Unit 11 — Airplanes. How airplanes are controlled. How airplanes get energy to move. How weather affects flying.

Unit 12 — A Hand Lens. What a magnifying lens can do. How we use magnifying lenses.

Unit 13 — Soil. What is in soil. How soil is made. Why soil is important to living things.

Unit 14 — Turtles and Other Reptiles. What snakes and turtles are like. How turtles and snakes live.

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* These units include health and safety material.

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